The New York City Electric Vehicle Readiness Plan: Unlocking Urban Demand

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The New York City Electric Vehicle Readiness Plan: *Unlocking Urban Demand*

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1 Executive Summary

New York has consistently embraced new transportation technology to make itself a better city. The City went from having no subways in 1904 to one of the world's largest systems in less than a decade. It embraced efficiency and improved public health by moving from the horse and buggy era to the age of the automobile. It revolutionized how American's drive by creating the Parkway, and it grew cleaner as its cars and trucks transitioned from leaded to lead-free gasoline.

Electric vehicles (EVs) present a similar opportunity to make our city cleaner and more competitive. Though New York has the lowest per-capita vehicle miles travelled of any major U.S. city, its overall size and density mean its roads are some of the country's most congested.[1] Over 2.5 million vehicles drive into and out of Manhattan every day. Electrifying those vehicles would help New York meet its air quality goals and reduce its greenhouse gas (GHG) emissions.

To better understand EV's potential, in January 2010 the City released an electric vehicle consumer adoption study (EV study).[2] That study looked at the City's grid, EV technology, driving patterns, and consumer preferences to see how EVs can work in New York. The study found that over 20% of New Yorkers are potential early EV adopters. They have dedicated parking, an interest in the technology and a willingness to consider the vehicle's total cost of ownership along with the potentially higher upfront cost. The study also examined the city's power system and found that it is suited to EV adoption. New York City has extra off-hour distribution capacity and low-carbon generation that increases the climate change benefits. Both because of market potential and environmental gains, EVs are a good match for New York City.

The City has an active role to play in spurring EV adoption through its purchasing power, ability to educate the public, and focus on making charging accessible. Over the last two years, it has implemented the top two recommendations from its EV study, increasing access to charging and increasing information and awareness about electric vehicles. It has also greened its own fleet and supported local businesses doing the same. Its actions fall into three broad categories:

1. conducting public outreach
2. increasing access to charging, and
3. improving vehicle economics

In the fall of 2011, the City and Empire Clean Cities received one of several grants from the Department of Energy to further plan for and support electric vehicle adoption. This grant has helped advance EV understanding and implementation potential across those three topic areas.

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[1] http://www.nyc.gov/html/dot/downloads/pdf/nyc_greendividend_april2010.pdf

[2] Exploring Electric Vehicle Adoption in New York City. Mayor's Office of Long-term Planning & Sustainability, 1/2010

Public Outreach

To raise electric vehicle awareness the City and Empire Clean Cities created a new online communication tool at http://missionelectric.org. Mission Electric helps explain the value and attributes of electric vehicles to New Yorkers, Bostonians and Philadelphians. Mission Electric is built on three insights, two of which were derived from the City's consumer research study and one from experience collaborating with the local garage industry. The first insight is that there are many potential early adopters who still lack a basic understanding of electric vehicles. Simply raising awareness of electric vehicles will push these potential early adopters towards a purchase. The second is that early adopters want to be part of a group. Mission Electric, an online social engagement tool that allows residents to vote on the location and composition of EV programs, helps foster that community. Because siting infrastructure on a hyper-local scale is difficult, crowd-sourcing also has the benefit of helping identify demand. The third insight, learned from the garage industry's response to a Mayoral event announcing charging in garages, is that the private sector wants recognition. The imprimatur of impartial government and non-profit parties has the ability to gain them more green credit than they would otherwise receive.

To date the site has run four engaging consumer projects in New York City and Boston and has had over 2,500 visits and an active Facebook page nearly 500 followers. In the most successful promotion, a public-private partnership with the New York drugstore chain Duane Reade, over three hundred New Yorkers voted on which stores the company's new electric trucks should serve. Duane Reade received greater public awareness of its green investments and New Yorkers participated in improving local quality of life.

Access to Charging

To increase charging access the City has pursued three goals: determining whether new parking facilities can be designed "EV ready", finding a pathway for economically sustainable curbside charging, and reducing the electricity costs of overnight charging.

Building new parking with EV readiness may allow the City to vastly increase access to charging. An average of 10,000 new parking spots are built a year in the city, and few to none are currently being built with electric vehicles in mind. Accommodating EV charging at these spots in the future could necessitate expensive retrofits and create coordination problems between garage managers, developers, building owners, and EV drivers. Requiring that a certain portion of new parking spaces be developed "EV ready" by laying conduit and reserving electric panel capacity, as cities like Vancouver and London do, would reduce the incremental cost of providing charging. This can be accomplished through amendments to the building code, which the City is considering as a result of the research made possible by this grant.

Providing electricity to food carts and trucks may create an economic and operational pathway for supplying curbside charging for New Yorkers who do not park in garages. Other municipalities have installed pilot curbside chargers and run into problems of higher costs—they are up to five times higher than garage installations—and limited demand. However, 40 percent of New Yorkers park on the curb, so providing charging will eventually become a necessity if the EV market grows to scale. New York City is considering a pilot for 2013 that would allow food carts and trucks to plug into smart outlets similar to curbside chargers. They will help New York learn how to provide charging while also serving users, the food vendors, that provide high utilization and revenue. New York has done an extensive canvas of the industry, identifying over 61 percent of vendors as using generators that are noisy, expensive to operate, and polluting. Serving food trucks and carts now makes economic and environmental sense and allows the City to serve electric vehicles later.

Identifying the geographic potential and economic challenges of fast charging is the last initiative to improve charger access. The City and other stakeholders looked at specific locations and zones along local travel routes to determine their compatibility with fast charging. The City found nearly 500 properties it owns within ½ mile of major highway exits that could be harnessed for fast charging. As part of its work on an electric taxi pilot, the City also analyzed the sources of high costs associated with fast charging and how energy management techniques such as load shedding could make fast charging more affordable and thereby accessible.

Electric Vehicle Economics

When looking at how to improve the economics of EV adoption the City studied problems that it had either already encountered or thought that it may be uniquely positioned to solve. The first is incorporating electric vehicles into car share by simulating how EVs would perform using the City's actual car share data. Car share vehicles have high utilization, which improves the financial viability of EVs. As an electric vehicle is used more, its lower operating costs reduce its per-mile total cost of ownership. However, there are concerns about whether electric vehicles are a good operational match for car share. Range anxiety, the concern that an empty battery will cause a vehicle to become stranded, is an even larger issue for communal vehicles, either those in car share or a fleet, since business depends on the certainty of operations. The vehicles have frequent daily trips by potentially different drivers who therefore are less able to know if a vehicle will have sufficient charge for his or her needs. New York City used data from its 2010 pilot as a fleet customer of the car share company Zipcar to simulate how EVs would perform using actual trip data. A sequential matching algorithm showed that 577 out of 582 trips, or 99 percent, would be possible with current battery electric vehicles. In this case, concerns about electric vehicles insufficient range are not grounded.

This tool can be used not only by New York to advocate for more EVs in its car share contracts but by other cities and fleets as well. It requires minimal data, easily obtainable through on-board diagnostics or through analytics such as Zipcar's Fast Fleet program.

Electricity prices are the second largest driver of a vehicle's total cost of ownership. To help reduce those the City and Con Edison have worked together to allow consumers to access cheaper overnight and off-peak electricity. The City's first steps included providing a waiver from regulations that prevented a homeowner from installing a 2nd electric meter. Using two meters a homeowner can charge his or her EV using time of use (ToU) rates that are up to 92 percent cheaper than the standard residential flat rate.[3] The second initiative, spearheaded by ConEd, allows cost-effective sub-metering,

[3] With a time of use rate, electricity prices vary depending on time of day.

providing the benefits of a 2nd meter (and additional smart grid features) with less additional wiring and lower upfront costs.

Finally, the City extensively researched the potential of vehicle to grid / vehicle to building technology (V2G/V2B). V2G/V2B, which harnesses a vehicle's battery to supply electricity, has the potential to not just reduce the cost of operating an EV, but also help it generate revenue or avoid other electricity expenses. Because New York City's EV fleet includes over 100 vehicles and is growing, it has the opportunity to help make the market for this technology. Though the technology is not yet commercialized the City can take steps now to make itself future-proof, namely by wiring its chargers with larger diameter conduit. This low-cost measure will make it cheaper to upgrade when V2G/V2B matures.

Conclusion

Electric vehicles already travel New York's streets for personal, City agency, and commercial trips. As they grow in number they could help New York better weather fuel shortages like those that occurred during Hurricane Sandy. Through diversifying vehicle fuel use, there will be less pressure on our gasoline infrastructure and more ability to use alternatively fueled transportation.

New York's electric vehicle initiatives are possible because PlaNYC and its goals have become a beacon for City agencies. The Health Department, which oversees food safety for mobile food vendors, understands how providing grid power to replace generators has air quality and climate benefits. The Department of Buildings, already having passed pioneering energy efficiency codes, is able to modify rules so that EV owners can install a second meter to access cheaper time of use rates. The Department of Citywide Administration has built the nation's largest municipal electric vehicle fleet in the nation. The Department of Transportation administers a $30 million federally-funded program to incentivize the purchase of alternative fuel vehicles.

Electric vehicles are a priority for New York because of the significant climate and air quality benefits they create. ConEd, The New York City Mayor's Office, consulting firm Pike Research and others have identified the area as one that's a good fit for EVs because of its density, hybrid ownership, and consumer profiles. Adoption is not preordained or easy, but through continued planning and tailored solutions New York can meet its potential for high EV penetration, and in turn improve the overall air quality for its residents.

2 Introduction

In 2007, the City released PlaNYC, its comprehensive sustainability blueprint. PlaNYC is a guide to prepare the city for one million more residents while improving the city's infrastructure, cleaning the air, adapting to a changing climate, and reducing greenhouse gas emissions 30 percent by 2030. The plan, available in Japanese and Chinese, created 127 initiatives and brought together over 25 City agencies to accomplish those goals.[4] PlaNYC has made sustainability a part of the City government's fabric. It has created inter-departmental pathways of cooperation that did not exist before. It is making New York a greener greater city now, and also enabling future waves of innovation.

Some signature projects in PlaNYC include the construction of the new 2nd avenue subway, the Million Trees initiative (which is 637,000 trees towards its goal), and the passage of a landmark suite of energy efficiency laws known as the Greener Greater Building Plan. The last initiative is particularly important since buildings account for over 75 percent of the city's total GHG emissions. The laws require that the largest 2 percent of buildings, which are responsible for nearly 45 percent of all GHG emissions, measure and publish their energy usage annually and tune up their buildings on a periodic basis. The Greener Greater Buildings Plan is expected to save $7 billion over ten years while creating over 17,800 jobs.[5] The City is also using its own buildings to lead by example and has committed to reducing GHG emissions from government operations by 30 percent in an accelerated timeline of just ten years.

Electric vehicles are integrated into PlaNYC as part of the transportation portfolio. Of PlaNYC's 127 initiatives, 15 percent are transportation related. The City's balanced transportation strategy includes cleaning vehicles while also reducing traffic and increasing bicycle, ferry, and transit use. The City has made its transportation footprint smaller and less impactful to the environment by shrinking its fleet, using biodiesel, and purchasing over 6,000 alternative fuel vehicles and 110 highway ready electric cars. and transit usage. In a time of scarce resources, it is tempting to pit one of these initiatives against the other. However, they're not necessarily mutually exclusive. Bicyclists appreciate vehicles without tailpipes and electric vehicles undeniably help meet the PlaNYC GHG reduction goal.

To evaluate the potential for electric vehicles in New York, the City released an electric vehicle consumer adoption study in January of 2010. The study looked at the City's electric grid, EV technology, driving patterns, and consumer preferences to see how EVs can work in New York. Approximately 40 percent of New York City's electricity is generated from clean energy sources making our power mix well suited to electric vehicles. With a heavy reliance on nuclear, gas and hydroelectric power, and almost no coal-fired power plants, EVs driven in the city are 40-90 percent cleaner than conventional and hybrid vehicles. EV's also improve air quality by reducing the NOx and PM 2.5 pollution that causes asthma and cancer.

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[4] NYC.gov/PlaNYC

[5] http://www.nyc.gov/html/gbee/html/plan/plan.shtml

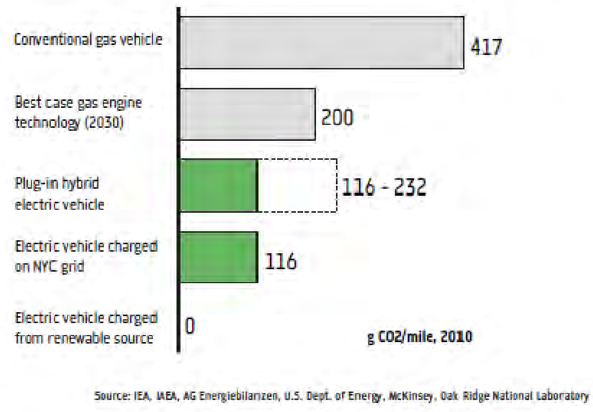

Figure 1: Emissions by Vehicle Type from previous NYC Mayor's Office EV Study

Con Edison, the local power provider, examined current and potential future demand levels to determine our grid's EV readiness. According to ConEd, today's power grid has enough capacity to charge up to 230,000 vehicles without any major upgrades, provided most charging occurs off-peak. New York City's power consumption is highly variable and while the grid is fully utilized on hot summer days it has spare capacity at night and in the early mornings. Encouraging charging in those off-peak hours will allow the company to minimize network upgrade costs for its ratepayers.

On the consumer side, the City surveyed nearly 1,400 New Yorkers.[6] 21 percent of those surveyed are potential early adopters (Figure 2).

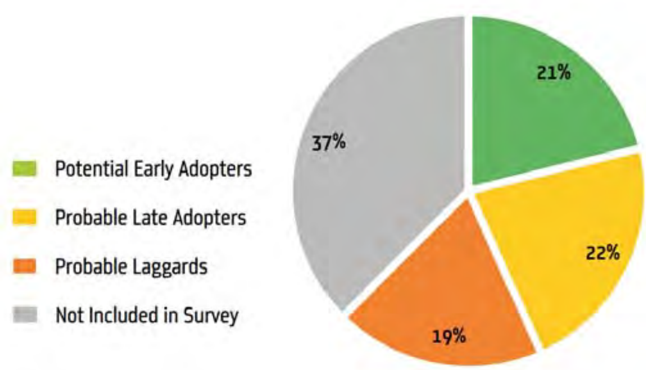

Figure 2: Attitudinal Segmentation of NYC EV Buyers from previous NYC Mayor's Office EV Study

The City can address many of the barriers they face, including a lack of information and limited access to charging. Indeed, the study placed the actions at the City's disposal on a cost curve and found that financial incentives are not necessarily more effective than far cheaper actions, such as improving zoning laws and created easily accessible online information. Many of the actions taken in this report, including creating Mission Electric and increasing charger access, are built on those findings.

[6] Though the study focused on consumers, commercial vehicles are also an excellent fit for electrification. The per-vehicle benefits are greater, and unlike personal trips, deliveries cannot be easily shifted to bicycle or transit.

3 Outreach through Mission Electric & Public Engagement

3.1 Overview

According to the City's EV Study, outreach is one of the two most meaningful ways to increase electric vehicle adoption. Outreach serves two purposes, education and visibility. Forty percent of potential early adopters are more likely to buy an electric vehicle once they better understand the technology. Even amongst potential early adopters for whom electric vehicles hold the most appeal, 67 percent still have limited knowledge of how they perform.[7] 21 percent were more likely to buy an EV if they had more information about charging, vehicle types and availability.[8] As neutral 3rd parties with local expertise, the City and local non-profits are the right agents to raise awareness.

In the summer of 2011 the City launched a basic electric vehicle website, NYC.gov/driveelectric. It provides information about the technology, links to charging maps, and a description of the requirements to install a home charger. The Drive Electric site also clarifies several common misunderstandings. For example, prospective buyers often do not fully understand the variety in EV models and technology. The distinctions between plug-in hybrids and full battery electrics can be lost, as well as the fact that EVs increasingly come in many shapes and sizes, including minivans and SUVs. Drive Electric uses the character studies from the City's consumer research study to show the variety of types and how electric vehicles do and do not work for typical New Yorkers (Appendix C-3).

However, the site does not address some key goals identified in the EV study. For example, the site does not promote visibility and recognition, which are important to EV early adopters since they are making a choice to be on the cutting edge. They want to be supported in their decision to reduce climate change and foreign oil dependence.

The City's outreach serves to make basic information available and accelerate adoption of electric vehicles. Early adopters support electric vehicle investment locally and nationally, and also lead by example in demonstrating electric vehicle viability, thereby paving the way for the next wave of adoption.

For those potential early adopters that do not have deep familiarity with EVs, the City and Empire Clean Cities have made it possible for them to see the cars in person and literally kick the tires. Empire

Figure 3: Electric Vehicle Sign in Central Park

[7] PlaNYC EV Study. January, 2010.
[8] Ibid.

Clean Cities and the City have spearheaded or participated in nearly a dozen showcases of electric vehicles. Some of these events were geared towards enthusiasts, such as National Plug-in Day, which the City co-sponsored in 2011 and 2012, or the non-festival world premiere of the documentary *Revenge of the Electric Car* at the Central Park band shell. That event drew over 500 people and showcased some of the electric cars in the City fleet. Other outreach efforts brought EVs to the people , such as Summer Stage and Central Park's Adventures NYC outdoor festival. In events with City vehicles, drivers from the Departments of Transportation, Sanitation, and Parks reassured New Yorkers that even after thousands of miles these vehicles work well. Through simple exposure, thousands of New Yorkers are now more familiar with electric cars. An additional example of this is in Central Park where several of the City's vehicles park and charge. According to the Parks Department this has become a minor tourist attraction.

EV Outreach Events
2011
1. Fleet Day in Flushing Meadows (May)
2. Screening of *Revenge of the Electric Car (*July)
3. Queens Chamber of Commerce Fair, Citi Field (September)
4. National Plug-In Day at Pier 54 (October)

2012
5. Fleet Day in Flushing Meadows (May)
6. Central Park's Adventures NYC (June)
7. Mission Electric Day at Staten Island Yankees Game (July)
8. Summer Stage Concert in Crotona Park, Bronx (July)
9. Tour de Queens Bicycling Event (July)
10. Harlem Auto Show (August)
11. National Plug-In Day in Times Square (September)

To better satisfy the need for community, New York and Empire Clean Cities collaborated with Boston, Philadelphia to create MissionElectric.org, a map-based social tool that allows New Yorkers to have a voice in electric vehicle infrastructure. The goal of Mission Electric is to get public feedback and create community around EVs. Potential electric vehicle early adopters want to be recognized and supported for being on the cutting edge. Mission Electric, through its website and through social media such as Twitter and Facebook, is a way for them and other New Yorkers to be part of a team that helps shape New York's electric vehicle infrastructure.

Purpose LLC and Open Plans, respective leaders in mass digital participation and open source mapping, helped create Mission Electric. The Mission Electric site enables users to vote on the location of EV focused events and programs. The first vote, done in both Boston and New York, allowed residents to choose which events Mission Electric would attend. It also allowed user submission, so that people could suggest a birthday party and have their friends vote to have Mission Electric bring an EV. These electrified events were a "soft launch", intended to test the website and raise visibility by attending physical events. Mission Electric went to five of the events, including all the top vote-getters as well as others.

The second higher profile initiative involved a collaboration with the large New York-based drugstore chain Duane Reade, which had committed to incorporate electric vehicles into its fleet. The campaign allowed New Yorkers to select which Duane Reade stores the company would serve only with electric trucks. To increase awareness about the campaign, the City worked with NYC & Co, which provided the pro-bono space to place physical ads on over 100 bus shelters (Appendix C-1). The campaign also received significant attention from online media sources, including press coverage from Triple Pundit, NPR, EV enthusiast blogs, and the fleet and drug store trade journals (Appendix C-2). Over three hundred users voted during the campaign, and seven stores, including the top vote getters in Park Slope and Howard Beach, won electric vehicle deliveries. The campaign successfully increased awareness of EV investments in the city and Duane Reade received recognition for its investments.

Figure 4: Bus Shelter Advertisement for Mission Electric

The third and final campaign involved a partnership with Hertz On Demand and helped to test the value of crowd-sourcing. This campaign, which ended in December 2012, enabled New Yorkers to vote on where they want to locate electric car share vehicles offered by Hertz. Up to three garages throughout the city could be selected to receive EVs provided that they received at least 100 email-affiliated votes. Unfortunately, none of the potential EV locations reached the vote threshold Hertz required, delaying the opportunity to test the value of crowd sourcing. Nevertheless, Mission Electric is an example of how a technology focused campaign can converse directly and easily engage with residents.

Engaging the public through crowd-sourcing has other benefits as well, including gauging demand and providing recognition for investors in green technology. Anticipating demand for an emerging technology like electric vehicles can be challenging, especially on a hyper-local level. For example, in 2011 the City and Columbia University used hybrid ownership, census, and demographic data to determine which neighborhoods were likely to contain early adopters; this same criteria is used by national charger providers to determine installation locations. Those proxies are useful, but incomplete. For example, they do not include travel pattern data to estimate visitor usage. In other cases, such as providing electric car share, there is even less data for estimating demand.

Design History and Choices for Mission Electric

The web and social media firm Purpose was an original collaborator on the design and structure of Mission Electric. The site was conceived as an outgrowth of NYC.gov/driveelectric. That site provides information about the technology, links to charging maps and requirements to install a home charger. It uses archetypal character studies from the City's consumer research study to show the variety of types and how electric vehicles do and do not work for typical New Yorkers (Appendix C-3).

Using stories based on the circumstances of typical EV early adopters makes information about chargers and vehicle attributes more accessible, but it still presupposes a consumer who is already far along the buying process. Those stories are most useful for someone already seriously considering purchasing an electric car. Mission Electric is designed to allow wider participation of EV supporters and prospective buyers by allowing them to engage through voting. Even if they are not ready to purchase a vehicle they can still participate and learn more about EVs in their city.

Creating a more engaging site required identifying the target audiences, planning realistic projects that people could vote on, and creating a website identity that encouraged participation. To meet the first and second goals Purpose led an internal and external ideation session. The larger session included representatives of the NYC DoT, Empire Clean Cities, The Office of Long-Term Planning & Sustainability, the City of Boston, and the City of Philadelphia (Appendix C-4). Participants were primed beforehand to consider EV activity in their communities, social engagement they find appealing, and potential projects they could see the website spearhead.

Scalability and Underlying Technology

One initial requirement was to create a design that could be used by multiple cities, in this case New York, Boston, and Philadelphia, but potentially others in the future. The site is built so that it can scale up to many cities with minimal extra design and hosting costs.

The user-facing design uses Wordpress, the web's most common blog and content management system.[9] The underlying map and voting tools are named Shareabouts and because they are open source other parties can repurpose them for their own needs. That code can be found at the website www.shareabouts.org. In addition to Mission Electric, Shareabouts has been used in Portland and New York to identify bike share locations, and was recently used to provide a real time list of Sandy clean up volunteer opportunities.[10] Features include a flexible layout, the ability to configure a map with boundaries and neighborhood names, and export the data.

Target Audiences

Discussions suggested that not all three cities shared the same audiences. For example participants felt that Boston and Philadelphia drivers have more pragmatic relationships with their cars while for many New York drivers—at least a third of early adopters as defined by the City's consumer adoption study—cars represent some part of their identities. With those differences in mind Purpose identified several target audiences:

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[9] http://techcrunch.com/2011/08/19/wordpress-now-powers-22-percent-of-new-active-websites-in-the-us/

[10] https://github.com/openplans/shareabouts/wiki/Projects-that-use-Shareabouts

- EV clubs & enthusiasts - motivated by their passion for EVs
- Early and prospective EV buyers - motivated by their desire to have an urban environment in which 'EVs make sense,' i.e. the infrastructure necessary to make owning an electric vehicle convenient, affordable, and sustainable
- People interested in sustainable transportation and urban sustainability – motivated by their passion for sustainable transport/urban sustainability
- Fleet managers - motivated by their desire for good PR, economic incentives, increased brand awareness & equity, potential increase in sales
- Bikers - motivated by their desire for clean air and sustainable transportation
- People interested in open government - motivated by their passion for participating in public decision-making and their city's governance

The site used its contests, blog content, and social media postings to appeal to those audiences. The following are emblematic tweets and the audiences they appeal to:

Open Government Supporters

EV Enthusiasts

Urban Sustainability Users, Open Government Supporters

EV Enthusiasts, Urban Sustainability Supporters,

Figure 5: Emblematic Mission Electric Tweets & Target Audiences

The Mission Electric name and logo were designed with attention to core brand attributes as well. The goals were to make the logo approachable, dynamic, and local. They were built to avoid appearing too policy oriented, irrelevant, or isolated. Purpose presented three values for the site to embrace: emphasis on public participation, potential to shape the city in a positive way, and the ability to make an impact quickly. The last value reflects the fact that electric vehicles are gaining market share and not just a technology that is perpetually over the horizon. Three finalist names and 18 logo designs were created and informally tested at both Purpose and OLTPS before choosing the final name and logo. For those alternatives and more detail on the branding process please see Appendix C-5.

Project Types

The ideation resulted in many promising proposals, including the three that New York City (and Boston in part) carried out: electrified events, e-truck challenge, and choose your car share. Each of these balanced achievability and engagement. For example, having New Yorkers vote on which City fleet should receive new electric sedans had high achievability but low engagement value. Likewise, having people vote on chargers has benefits for EVSE[11] installers by identifying demand, but as a campaign it appeals primarily to existing EV drivers. Though the campaign has high achievability, it would risk not generating enough engagement. For those reasons those proposals were not further developed. Below are chosen projects' and their attributes:

	Description	Value Proposition	Target Participants	Partners
Electrified events	People collaboratively decide which events should be 'electrified' with the presence of an EV	PR opportunity for event producers; opportunity for electric asset owners/brands to showcase them and train drivers to discuss them with the general public	Event attendees, EV enthusiasts, people interested in sustainable transportation and urbanism	Event producers; EV asset owners
E-truck challenge	People collaboratively decide which neighborhoods should be serviced by the electric trucks of participating companies	Heightened visibility and buzz for brands with EVs in their fleets	EV fleet brand's consumers and employees, EV enthusiasts, people interested in sustainable transportation and urban sustainability	Brands with EVs in their fleets
Electric car share	People collaboratively decide which car-share locations should offer EVs	PR and customer engagement opportunity for car-share brands, along with greater awareness and higher utilization of winning locations	Car-share consumers, partnering car-share brand's employees, general car-share users, EV enthusiasts, people interested in sustainable transportation and urban sustainability	Car-share brands

The Challenges of a Public Private Partnership

The promise of Mission Electric is partly in combining the credibility of the public sector with the investment power of private industry. Raising awareness of private EV investments is good for both the City, which wants to encourage adoption, and also the businesses that want credit for their environmental commitment. Each partner weighs these benefits against the reputational risk working

[11] EVSE stands for electric vehicle supply equipment. EVSEs are commonly referred to as chargers. EVSE is a more technically accurate descriptor, but for readability this report uses the two terms interchangeably.

together creates. Businesses fear allowing the public too much say in what are traditionally internal decisions like truck routes and car share placements. For its part, the government fears both "playing favorites" with private companies and creating false expectations with the public. Unfortunately, those concerns can lessen the attributes that make an online vote exciting to the public. Mission Electric surmounted those issues, but it took the careful selection of partners and restructuring of both e-truck challenge and electric car share. Only a select few partners were able to provide a compelling contest for users and meet social equity and policy requirements of the government partners. For example, with the Duane Reade campaign, some vehicles were pre-assigned to neighborhoods with high asthma rates. While this ensured that policy goals were met, it reduced the dynamism of the contest by limiting the available number of locations up for vote.

Recreating a Mission Electric style engagement requires many potential partners since some, despite a good faith interest, will be unable to meet the project requirements. A public-private partnership can increase investment and public acceptance, but it requires meeting both private operational requirements and non-profit or government social standards. Only a subset of partnerships can meet those dual needs.

3.2 Measurement Metrics & Campaign Results

Several tools are used to measure Mission Electric's online reach:

Google analytics tracks details on Mission Electric such as what type of device a user is browsing from, if they came directly, via search, were referred by social media, another website, or email, and what region they were from. Analytics also shows how long a visitor stayed and what pages they visited.

Bit.ly is a URL forwarding service. For example, http://bit.ly/MPNlry will get redirect users to http://nyc.missionelectric.org. Bit.ly has two functions: conserving space for Twitter posts, which allow a maximum of 140 characters, and tracking specific outreach. Mission Electric created new bit.ly links for each campaign.

Facebook analytics provides engagement and demographic data. It shows how frequently Facebook links are shared, how much they're liked, and their reach, or how many people see our content through either advertising or through being shared by friends' feeds.

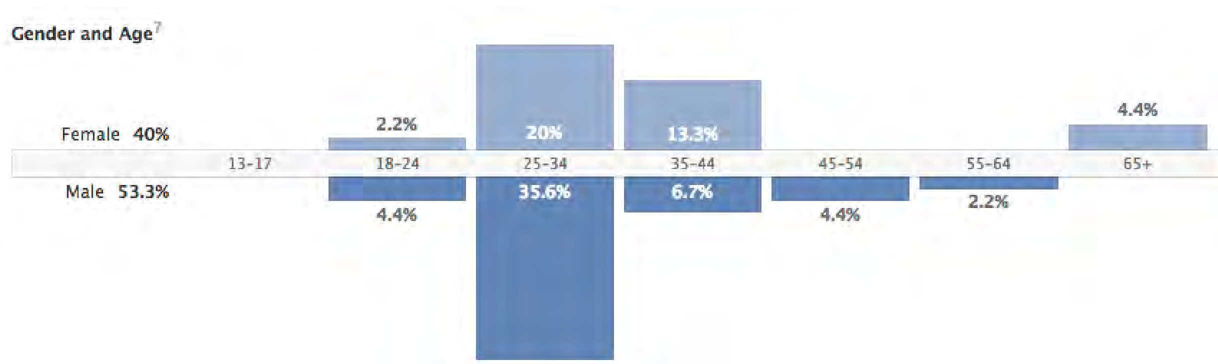

Figure 6: Demographic Information on Mission Electric Facebook Friends as of 12/10/2012

By every measure, the first campaign, the e-truck challenge was the most successful. It received over 1,800 site visits, 300 votes, and earned mass media articles from several sources, including triple pundit and plugincars.com, both of which represent two of the key audiences identified in the City's EV study.

Components that made the campaign successful included:

- Campaign press event/ photo-op with the City's Director of Sustainability
- A coordinated social media strategy with Duane Reade and Mission Electric
- The use of donated bus shelter advertising with a market value of over $200,000
- Duane Reade in store promotion: In store radio and aisle advertising (Appendix C-6)
- Duane Reade online advertising (responsible for 20 percent of traffic to the campaign)
- Physical event participation (Summer streets NYC truck showcase)
- Large giveaway (a gift basket worth $250)
- Duane Reade store employees engaged and voting

Duane Reade's considerable web and street-level presence helped to drive the success of the campaign. The company promoted the e-truck campaign prominently on its homepage, generating over 300 referrals for the month it was active. In social media, the company has over 57,000 Facebook friends and 143,000 Twitter followers, which it also used. This revealed itself on August 22, 2012 when nearly two thirds of referral traffic came from social media during a day Duane Reade tweeted and posted on Facebook. The remainder came directly from Duane Reade's website (Appendix C-7).

New York City also lent its social media support, tweeting from NYC.gov (with an audience of over 50,000), GreeNYC, 311, the New York City Mayor's Office and Office of Social Media, and the Parks Department.

On the other hand, sites with a more targeted, EV audience referred far fewer people despite their alignment with Mission Electric. For instance on October 25, 2012, the Hertz campaign launched with an article in Greencarreports.com. That article led to only nine people logging on to the website that day. Greencarreports has a smaller overall audience (42,000 Facebook fans, 9,000 Twitter followers), but not markedly so. However, as a national site it likely has far fewer New York City readers. This indicates that having the support of a partner with large local reach is important, even if their audience is broader than the EV enthusiast community.

There were several reasons that the Hertz campaign did not achieve the momentum that Duane Reade did. First, Hurricane Sandy caused a significant disruption. The City did not promote the campaign for over three weeks as its social media channels focused on storm-recovery topics. Second, Hertz did not advertise or promote as heavily, either to its customers or the media. The lack of a physical kickoff event also likely reduced the press coverage potential. Hertz also realized that it picked several locations ill-suited for electric vehicles and adjusted them. Each of these factors delayed promotion and dampened initial participation.

	Hertz	Duane Reade
Visitors	949	1775
Votes	130	301
Days	53	56
Facebook Likes	397	95

Figure 7: Key Metrics from Hertz & Duane Reade Campaigns

Finally, the Hertz campaign was constructed as one that would launch in both Boston and New York. Hertz and representatives from Boston were unable to find agreeable locations and were therefore unable to create a partner project. As a result, the campaign had lower than expected organic growth and earned media. Hertz required that a site have at least 100 email-affiliated votes for the company to guarantee adding a vehicle and none of the locations met that threshold (Appendix C-8).

Surprisingly, though there were less votes and visitors during the Hertz campaign, Mission Electric's following on Facebook surged during this period. Partly through judicious use of advertising, the social media postings reached nearly 25,000 people and posts from November 14th through December 7th, 2012, received 142 likes. This reflects that Mission Electric can have a social media presence and impact even in the absence of an active website mission.

3.3 Communication

Mobile Interface

One clear design limitation is the lack of mobile interface. Approximately 20 percent of users logged in using a mobile device. Faced with an interface that did not allow them to vote or easily navigate, nearly 80 percent of those users left within seconds. This most significantly affected users on Twitter, who most frequently visited from mobile devices. Mobile and tablet computing is the fastest growing computing segment. Tablets alone are expected to exceed laptop sales by 2017.[12] Adding a mobile interface is a top priority.

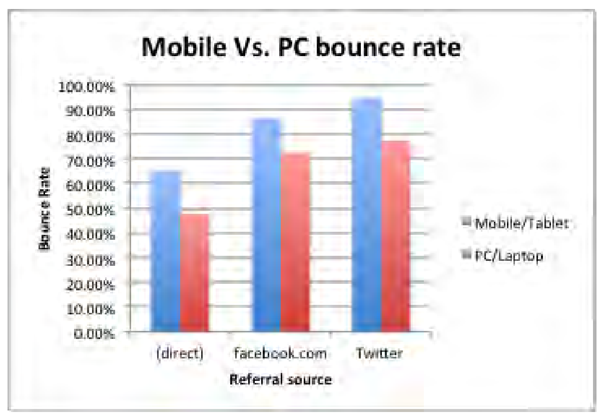

Figure 8: Comparison of Mobile & PC Site Engagement

[12] Quarterly Mobile PC Shipment and Forecast Report, NPD Group. 2q 2012. http://www.displaysearch.com/cps/rde/xchg/displaysearch/hs.xsl/quarterly_mobile_pc_shipment_and_forecast_report.asp

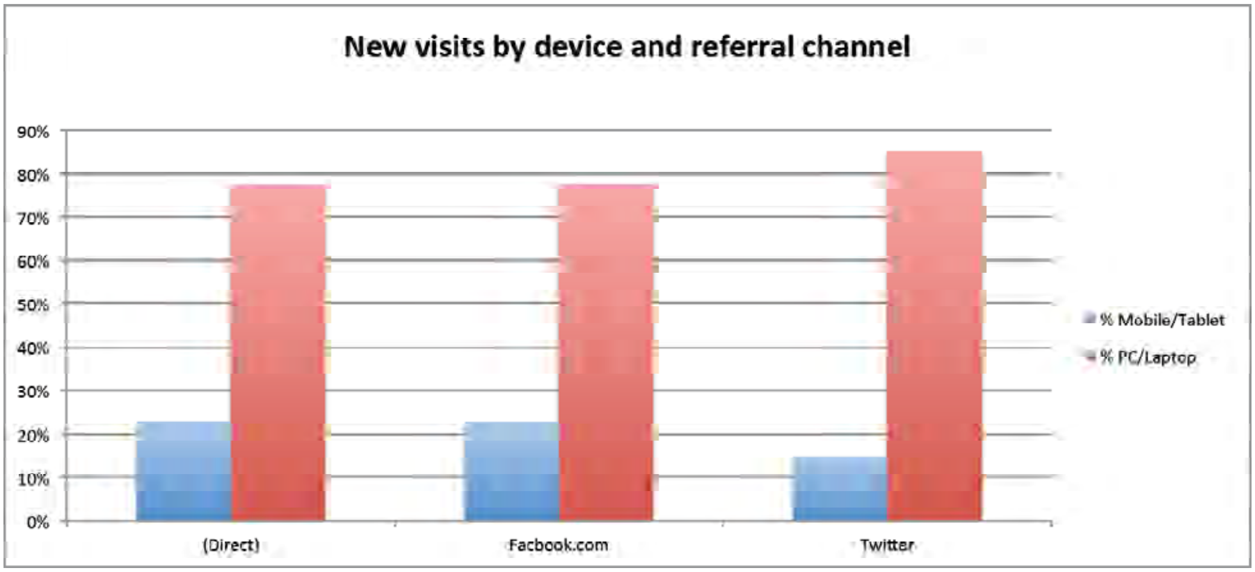

Figure 9: Mission Electric Sources of New Users

Communication Channels

To reach its audience Mission Electric primarily used email, Facebook, and Twitter. Mission Electric sent out 6 email blasts. Overall, all campaigns saw an average open rate of 35 percent. In comparison, the average open rate for non-profits is around 20 percent.[13] This relatively high rate reflected judicious use of the tool, a receptive audience, and the sharing of real news. The kick off emails did far better than the updates or subsequent emails urging recipients to vote.

Facebook: The most successful posts used strong images. For instance, over 8,000 users saw the post to the right. The post with the highest reach was also an image, this time submitted by a Mission Electric follower in Europe. In the picture we see an example of EV car share in Paris. This image drew 208 organic users, with an overall viral reach of 6,692.

Overall, Mission Electric's reach was higher when posts were picked up by organizations with large visibility such as Duane Reade.

Twitter: Twitter analytics are harder to quantify, but good measures for virality include mentions—the number of times that others used the Twitter handle @MissionEV—and retweets--the number of times that a tweet was picked up by other users. Overall, Mission Electric had 107 mentions and 60 retweets.

[13] http://mailchimp.com/resources/research/email-marketing-benchmarks-by-industry/

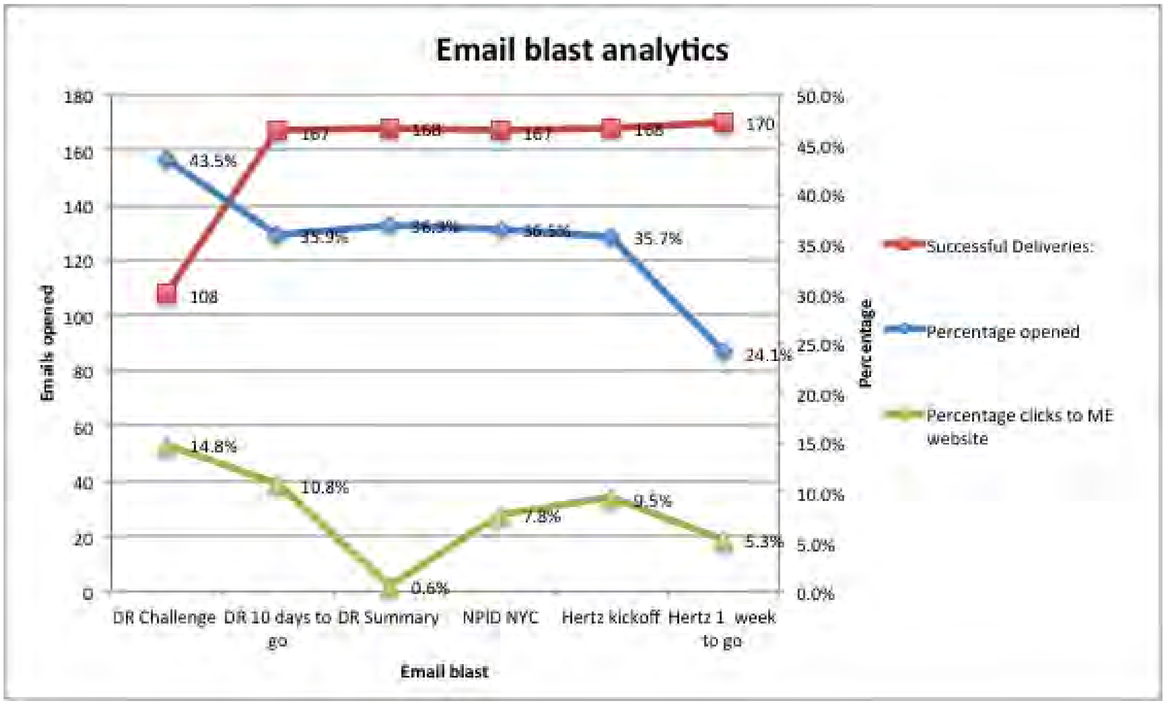

Figure 10: Email Reach and Audience Reception

These statistics indicate that Mission Electric has a strong relationship with its audience, but one that cannot be taken for granted. Emails with less actionable information received less attention. Growing this audience would help ensure a stable base of voting for future campaigns in their area.

Conclusion

Mission Electric pioneered empowering residents in New York and Boston a say in electric vehicle infrastructure. Early adopters want to participate in a community, through voting or other means. Voting is also a vehicle for recognition for the EV or EV infrastructure providers. However, voting is not without challenges. Projects must lend themselves to map-based representation and partners have to be comfortable with relinquishing some decision making to the public. Yet as the Duane Reade campaign demonstrates, a successful project creates visibility and excitement in a way that a traditional press release or event would not.

Mission Electric would likely benefit from expansion into other cities. Scale would allow the site to increase the frequency of campaigns, audience and overall excitement. The costs, in terms of additional hosting and labor would be modest. Regardless, key EV stakeholders should consider also creating a local, consumer-focused channel for electric vehicles in their communities.

Increasing Charger Access

As of December 2012 New York City has nearly 100 public level II chargers. It does not yet have any DC fast chargers though two are currently being installed as part of a taxi pilot. Thanks to grants from the New York State Energy Research and Development Authority (NYSERDA) that number will grow significantly. The City, through a NYSERDA grant and in partnership with the New York Power Authority (NYPA), will install 53 chargers in public garages that it already owns. Those chargers, and an effort to expand level I charging described on the following page, help meet demand in areas under-served by the private sector.

This section describes three other opportunities evaluated by the City to expand access to charging: on the street through a food vendor electrification pilot, in garages through creating EV ready parking spaces, and on the go through fast charging. These initiatives reflect the specific challenges and opportunities New York faces.

Building code changes that require a subset of parking spaces to be EV ready or have chargers have the potential to increase charger access now and in the future. This is a policy that cities such as Vancouver and London have embraced. In just one year plus the time of construction building codes could increase the number of EV-ready spots in the City twenty-fold. Though this would only affect new-build parking it would still have wide benefits thanks to New York's density. Garages are rarely private and are instead usually open to the public. Therefore a new garage with EV chargers increases EV buying potential for all those nearby. A new parking garage with chargers or the ability to cheaply install them would be a valuable piece of neighborhood infrastructure.

Providing electricity to food vendors may pave the way for curbside charging. Food vendors have slightly lower power needs than EVs, a clear willingness to pay, and predictable operating patterns. By honing a curbside electricity service with this subset of users now, the City will learn how to provide a cost-effective, similar service for EVs. The only way the City will provide curbside charging at scale is if it can find a profitable or revenue neutral business model.

Fast charging is another charging method that may unlock demand. It alleviates range anxiety and may become a way for high usage fleets such as taxis to operate electric vehicles. Unfortunately land and electricity costs limit the business models that make it work. The City has identified nearly 500 properties it owns in desirable fast charge locations. Though not all of these will be suitable for hosting a fast charger, the City owns enough properties to find geographically and operationally appropriate sites. However, the City believes that it is not primarily property costs but electrical ones that are the key barrier to providing fast charging. Demand charges, which pay for the grid requirements of fast consumption, are the key economic problem. It hopes to help drive down those costs by working with stakeholders such as charger manufacturers, building energy management system providers, Con Edison and the Public Service Commission.

Level I Charging & Garage Training

Beyond the three initiatives above, the City also reached out to parking garages and lots to see if they would provide wall (or level I) charging for electric vehicles. Approximately 30 garages in the Bronx, Queens and Brooklyn now offer outlet access to customers with electric vehicles. Wall charging, or using a cord to plug into a standard outlet, is not as fast or convenient as using a dedicated charger. It takes at least twice as long and requires a vehicle owner to use their own cord. Still, for plug-in hybrids or extended range electrics like the Volt, it can be sufficient. General Motors has found that over 60% of Volt owners use an existing standard outlet at home instead of installing a dedicated charger. Those vehicles can fully charge overnight using a wall outlet. Garages that offer this service make it easier for New Yorkers to use plug-in hybrids and it is also a step towards them offering faster level II charging later.

Additionally, Empire Clean Cities and Beam Charging trained over 250 parking attendants in 30 garages with chargers and created a manual (Appendix H) on how to properly use the equipment. Garages provide a lynchpin of New York City's charging infrastructure and often it is the attendants, not the drivers, who will plug the car into the charging equipment. Drivers need to be confidant that their vehicles will be returned with the range they expect, lest they lose confidence in using garages for charging.

4 Electric Vehicle Building Codes

4.1 Overview

New York is a City built on anticipating the future. In 1811, a plan was developed to overlay a street grid across the agrarian and wild landscape of upper Manhattan. Our reservoirs and water tunnels, begun in the mid-19th century, are still a marvel of engineering and make up the largest unfiltered urban water system in the country. Finally, in just 25 years we created the bulk of the subway system that we rely on today. Preparing for electric vehicles does not require the same audacity, but it does call for similar forethought in anticipating the infrastructure needed as more vehicles require charging.

Building new parking to be "EV ready" does not need to be expensive and is certainly cheaper than ex post facto retrofitting. While adding a few chargers can often be accommodated with existing infrastructure, meeting anticipated future adoption can become quite expensive if not initially planned for. Many of those costs can be avoided by planning for electric vehicles now. For example, in a surface lot, the cost of trenching and repaving a parking lot to accommodate the duct for wires is far more costly than laying that duct from the beginning. In most circumstances the cost of adding the electrical capacity and electrical conduit to a parking spot is less than $100 per spot, which is modest in the context of buildings that often cost millions of dollars.

Since 2009 London and Vancouver have used their building codes to prepare for EV adoption. They both require 20 percent of new residential parking to be built "EV ready". London goes even farther, requiring EV ready spots and chargers not just for residential buildings, but for retail and workplace parking as well. Vancouver's codes have been so successful that it is considering expanding them.

	London (Residential /Workplace/Retail)	**Vancouver (Residential)**
Chargers Required (%)	20/20/10	-
"Charger Ready" Spots Required (%)	20/10/10	20
Combined Total (%)	40/30/20	20
Year Introduced	2009	2009

Vancouver & London's approach may be applicable to New York as well. Despite an overall loss of parking, city developers still build plenty of new parking every year. In fact, starting in 2009 an average of over 10,000 new spots have been permitted annually.[14] The new build parking permits exhibit surprising diversity. It is built in all five boroughs, paired with buildings of all sizes, in both commercial and residential facilities (Appendix D).

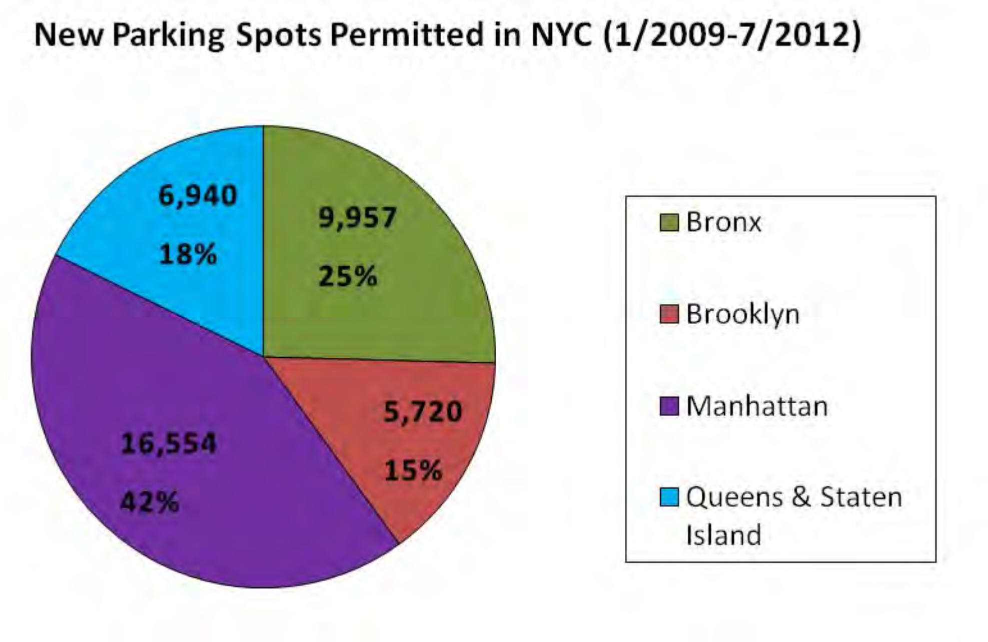

Figure 11: New Permitted Parking by Borough

Background

For longtime garage parkers, it is surprising that so many new spots are being built. Surface lots all over the city have been closed to make way for new buildings, causing the overall number of off-street parking spots to decline. Yet, while many parking lots are being built on, the edifices that replace them still include parking. Developers can build parking without necessarily reducing commercial or residential space. Parking in a basement or sub-basement level does not count against "floor area maximums".[15]

Past is not necessarily prologue, but the market for the continued building of parking should remain robust. New York has gained nearly 1 million people since 1990.[16] PlaNYC forecasts even more new residents, with New York growing to 9 million people by 2030. New housing will have to be built to accommodate those people. The steadiness of past parking constructions indicates stability as well; from 2009 through 2012 parking construction has remained remarkably constant. Though the Department of City Planning is considering regulations to reduce required parking minimums, there is still market demand for car ownership. As long as New York continues to grow, developers will continue building thousands of new parking spaces.

[14] For locations that require four or more spots. Parking below that number is not recorded by the Department of Buildings.
[15] http://www.nyc.gov/html/dcp/html/zone/glossary.shtml#floor
[16] http://www.census.gov

4.2 Code Models & Language

Like most other building codes, New York City's is based on the International Code Council model language. That means building code language can be shared across the country. Unfortunately Vancouver bases its code on the National Building Code of Canada, making it difficult to replicate this code language in the ICC model.[17] However, the code's requirements, both in terms of percentage of parking impacted, and the conduit and electrical panel goals are time tested and transferable to other model codes. They were passed in 2009 and government experts consider them well received.

Vancouver Code Language:

Part 13 of Division B: Environmental Protection Regarding Multi-Family Dwellings

- 13.2.1.1 – Parking Stalls - 20% of the parking stalls that are for use by owners or occupiers of dwelling units in a multi-family building that includes three or more dwelling units, or in the multi-family component of a mixed use building that includes three or more dwelling units, must include a receptacle to accommodate use by electric vehicle charging equipment.
- 13.2.1.2- Electrical Room-The electrical room in a multi-family building, or in the multi-family component of a mixed use building, that in either case includes three or more dwelling units, must include sufficient space for the future installation of electrical equipment necessary to provide a receptacle to accommodate use by electric charging equipment for 100% of the parking stalls that are for use by owners or occupiers of the building or of the residential component of the building.

Initial analysis suggests that these parking rules can be incorporated into sections 406.1 through 406.5 of Chapter 4 of the New York City building code. This section, "Motor Vehicle Related Occupancies", covers structural requirements for garages and parking facilities.

Next Steps & Conclusion

Increasing access to charging is a prerequisite for large-scale electric vehicle adoption. Building EV readiness into new build parking may strike the right balance of costs and benefits, since the installed electrical conduit allows for the affordable installation of chargers when they are needed. New York City is considering incorporating EV parking initiatives into its Green Code Task Force process.[18]

[17] http://www.bccodes.ca/vancouver-bylaws.aspx?vid=QPLEGALEZE:bccodes_2012_view

[18] The Green Codes Task Force, a PlaNYC initiative, proposes changes to construction codes and regulations that support green building strategies.

5 Curbside Charging in New York City

Curbside charging may become important in New York City. In each of the five boroughs, the percentage of car owners parking on the street ranges from 22 to over 54 percent, a population that must eventually be served to maximize EV adoption.[19] However, the challenge is matching supply of curbside charging with demand and taking into consideration the many other compelling and competing uses for the curb. Currently in New York, garage charging is still not fully utilized. Other Northeastern cities with chargers in the public right of way have spent thousands of dollars on installation and also seen lower utilization in those spots than in adjacent parking. The low usage and high cost of electrifying parking spots makes it difficult for the City to pursue *in the short-term*.

However, the City is exploring ways to provide curbside electricity now that will make curbside electrification easier later, both economically and operationally. The method New York is looking at is providing electricity through existing light poles for food vendors. There are 3,000 food trucks and carts in New York City, many of which use high cost, high pollution generators:

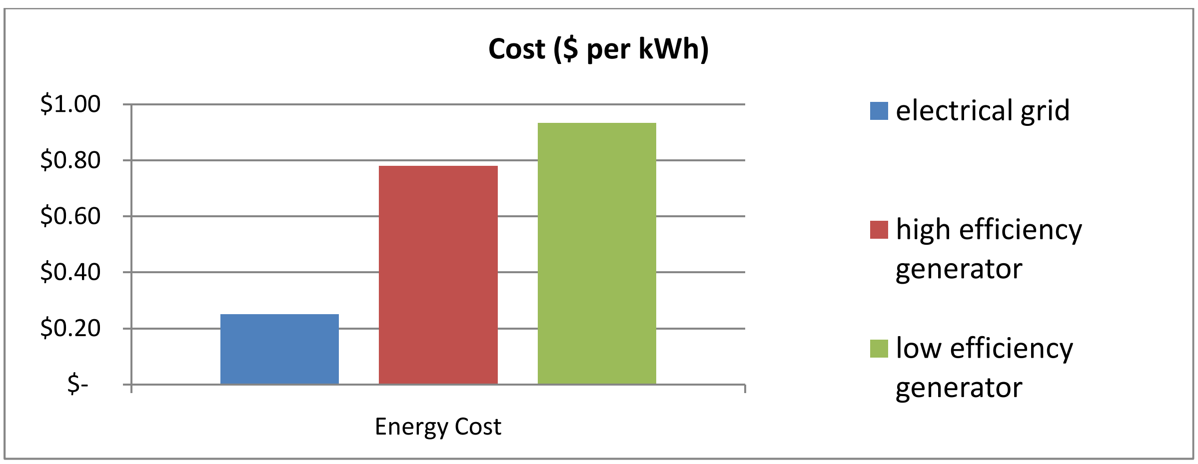

Figure 12: Costs of Grid and Generator Power[20]

[19]New York City Electric Vehicle Adoption Study, February 2010

[20] As estimated by OLTPS based on generator efficiency and average New York City electricity and gasoline prices

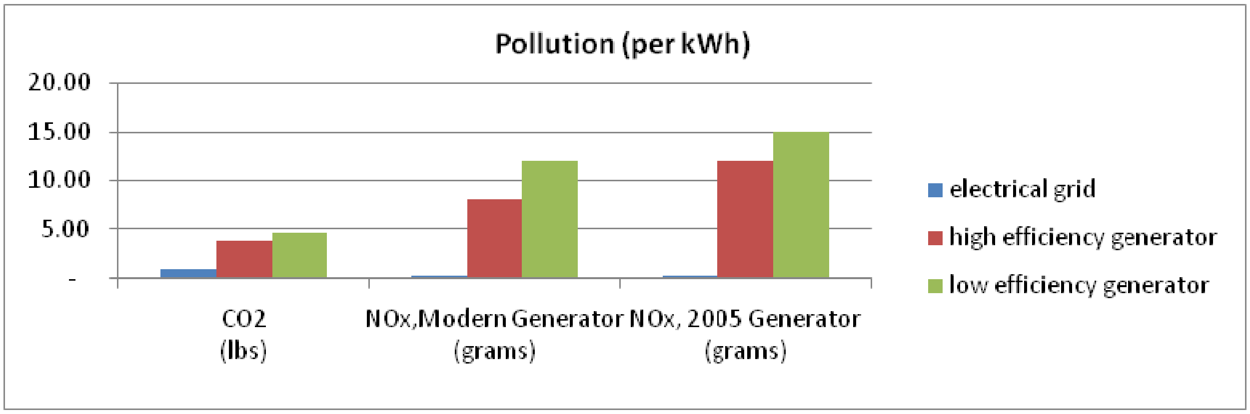

Figure 13: Pollution from Grid and Generator Power

New York City benefits in several ways from using this market as a proxy for EV charging and focusing its planning efforts on first providing it with curbside electrification. First, the outlets provided for food trucks are electrically very similar to those for vehicles and they can be retrofitted for eventual EV usage. They may then serve double duty, charging food carts in the daytime and vehicles at night. Second, it gives the City an opportunity for hands on learning on how to provide electricity to private users at the curbside. Because food vendors are a regulated and limited group of customers, the City can gain expertise for eventual curbside charging in a controlled way. Finally, because of their established routes and high current fuel costs, they provide a more certain return on investment (ROI). This financial return would allow the City to more easily expand the program if it chose to charge for the service.

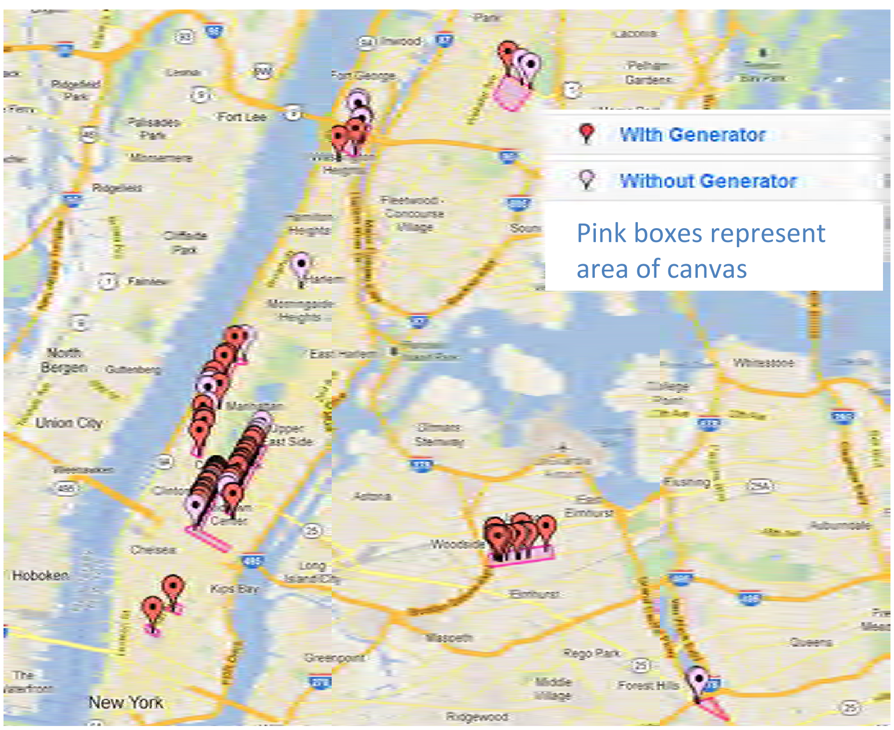

Figure 14: Map of Food Vendor Canvas

In pursuing this planning, the City is working with many stakeholders in the design of this potential pilot, including the New York City Parks and Transportation Departments, Con Edison, and a provider of charging for food vendors, Green Vendors NYC. It worked with a consultant, Closed Loop Advisors, which analyzed food cart and truck energy usage to determine potential market size. That company's report, done on behalf of OLTPS as part of this EV planning grant, includes an in-depth logistical analysis (Appendix A).

Food trucks & carts are an increasing part of the streetscape. Surveying suggests that approximately two- thirds of the 3,000 mobile food vendors use generators, adding noise and pollution to our already loud and congested streets. To address that issue, and to help understand how to one day provide curbside charging, the City is considering creating a pilot to provide food carts & trucks electricity. Soon several vendors may have the option of using grid power instead of generators.

Generators are noisy and often a source of community complaints. In fact, according to consumer grade decibel meters, some carts' generators are as loud as chainsaws. Beyond noise though, they are also polluting. According to an analysis by Closed Loop Advisors done for the Mayor's Office of Long-term Planning & Sustainability, generators produce 5 times more CO2 than the grid and well over 100 times more NOx (which causes smog, lung damage, and asthma). Vendors do not like the generators either. They require frequent fill ups, break down, and are expensive to use. In fact, at $1.15 per kWh, generator power costs at least four times more than grid power.

To understand the market Closed Loop Advisors and NYC Service collaborated on a strategic neighborhood canvas (Figure 14). NYC Service interns visited seven neighborhoods with a large number of food mobile vendors. They quantified the number of vendors using generators and the sizes of those generators. Over 67 percent of vendors use generators, showing that there is a significant market for providing electricity for food carts and trucks.

Figure 15: Potential Unit to Mount on a Light pole

Closed Loop also did a bottom up analysis of several trucks to determine what types of vendors would be likely candidates for electrification. Some trucks, predominately ones that make soft serve ice cream, yogurt or ice, require too much power to use existing electrical infrastructure. However the canvas suggested that of the vendors that use generators, 90 percent are a size that could be served with grid power.

The City is considering whether to implement a pilot to provide power to several carts and trucks. The pilot could work by utilizing excess electrical or conduit capacity serving the city's light poles.[21] The units themselves will be on the light poles, adjacent to them, or both.[22] The outlets will be secured through technology like RFID enabled access that already exists for marina and electric vehicle chargers.

[21] The existing conduit may be large enough in diameter to accommodate additional wiring.
[22] According to the Department of Transportation light pole installation will increase pole maintenance complexity. A separate pole mount may be price comparable, but it increases street clutter and may require protection from potential vehicular impacts.

Authorized users will need to tap the unit with an access card for power to flow. Figure 15 shows an image of the unit likely to be tested.

The pilot will help answer questions regarding vendor interest, electricity usage, and pedestrian compatibility. It will also provide experience with hardware on the street that will lower installation costs if the City does eventually decide to provide curbside charging for vehicles. By working first with food carts and trucks an immediate pollution problem can be fixed while also generating revenue. Though these units are built just for food vendors, future ones could serve double duty, providing power to both vendors and electric vehicles. Through both learning and future dual-purpose hardware it paves the way for a future when vehicles can charge on the curb.

Process of identifying food trucks & carts as a means to curbside electrification

New York City convened with the cities of San Francisco, Vancouver, Boston, Portland Oregon, Washington D.C., London, and Philadelphia to discuss their curbside charging strategies. It also conferred with its Department of Transportation, charging company providers, and other stakeholders to understand the barriers and potential of providing curbside chargers. Portland has been particularly successful with its Electric Avenue, which is near the central business district, but New York is in a unique situation because of the high demand for parking. According to the City's Department of Transportation high parking utilization means that creating dedicated EV parking now would likely result in higher overall congestion, by increasing the amount of double parking and searching for available parking by conventional vehicles.

The City first considered pairing vehicles that offer guaranteed high usage with curbside electric spots. It approached both Zipcar and Hertz on Demand, two of the biggest car share companies in the City. Both preferred using their existing garage model. Hertz identified the high installation costs of curbside chargers as a significant barrier. Indeed, interviews with representatives from other cities suggested installation costs could be three to five times greater than in a garage. In New York, which has the highest construction costs in the nation, those differences would likely be even greater. Furthermore, the additional concern of vandalism or neglect added additional potential maintenance costs. Together both high costs and uncertain demand outweigh the current benefits, especially since the City's 2010 study concluded that it would not induce demand as much as increased education and outreach.

Of the solutions considered for furthering curbside charging, creating a neighborhood cluster of EV charging, pairing with a car share firm, and providing power to mobile food vendors, the last offered the lowest costs and highest benefits. Installation would be simpler and easier, utilization would be higher since customer usage would be more assured, and willingness to pay would be greater since food vendors' current source of electricity is expensive, unpleasant, and unreliable.

Economic analysis by the City suggests that providing power from light poles could have as little as an 18-month payback:

Revenue Sensitivity Analysis

	Scenario 1: Base Case	**Scenario 2:** Higher Capital Costs	**Scenario 3:** Higher Costs, Lower Usage
Scenario Variables			
Scenario 1 = expected costs, Scenario 2= 2x CapEx, Scenario 3= 2x CapEx, less usage and labor			
Capital Expenditures (CapEx)	$ 800	$ 1,600	$ 1,600
Chargers / Employee (Labor Costs)	350	350	275
Annual electricity cost increases	3%	3%	4%
City share of revenue	70%	70%	50%
Hours a day of usage	7	7	5
Results			
IRR	845%	132%	10%
NPV	$ 47,040	$ 42,207	$ 4,653

Figure 16: Revenue Projections under three Scenarios Estimating Different Revenue and Operating Expenses

Pursuing food vendors is not unlike Tesla's strategy of first producing its Roadster. It focused first on a high margin product and offered it to a receptive, relatively small audience. It used its newfound expertise to reduce costs and then offer a solution to a larger part of the market. There are many challenges with curbside charging, including uncertain demand, high capital costs, and ongoing maintenance. This pilot aims to reduce installation costs and provide data to better estimate maintenance and operating costs for curbside charging later.

6 Fast Charging

The following is a two-part analysis of fast charging in New York City. In comparison to standard 6.6 kW level II AC charging, fast charging ranges from 25 to 90 kW. This allows many vehicles to nearly or completely fill up in 30 minutes or less. The technology has value to consumers for reducing range anxiety, but it may have value for heavily used commercial vehicles as well.

The first part of this analysis incorporates lessons learned from efforts to install three fast chargers this summer as part of a fleet project, specifically an electric taxi pilot. The locations being sought put a premium on usability for taxis. Though this analysis is the most localized, it may still be valuable for other regions. While some challenges are unique to Manhattan, the economic challenges encountered may be different only in degree and not in kind from those faced elsewhere in the country.

Secondly, a group of government transportation experts identified locations in the metropolitan area to place chargers primarily for passenger vehicles. The goals guiding this process were: proximity to both major travel routes and amenities, and nearby property owned by key stakeholders. The final results are regional locations identified on major corridors and GIS maps showing City owned properties within ½ mile of exits on key city highways (Figure 21 though Figure 25).

Convenience to travel routes has obvious import. An inconveniently placed charger will not reassure drivers with low batteries or range anxiety. However, proximity to nearby services such as coffee shops matter as well. EPRI studies show that the rate of fast recharge is not linear. Recharging speed diminishes after the first fifteen minutes.[23] Not all drivers will wait the full thirty minutes to get every kilowatt-hour. Nevertheless, a quarter hour to twenty-minute wait without bathrooms or nearby amenities may test users' patience.

The final goal, using stakeholder property or offering it for a franchise, may help quicken the siting of fast chargers. Some private landowners have embraced the value of AC level II chargers in general. However the experience of attempting to site fast chargers for the taxi pilot suggests that fast chargers create more significant objections from building owners, in part because of the greater electrical and spatial requirements for such chargers. The unproven value and greater demands of fast chargers make some building owners hesitant to partner on installations. New York City has not only encountered those concerns locally, it has also heard them from utilities and fast charge providers elsewhere.

6.1 Fast Chargers for Taxi usage

In the spring of 2013, New York City plans to launch a pilot of six single shift electric taxis. Globally, other electric taxi projects far surpass this one's modest scope, six Nissan LEAFs taking street hails for one year. Mexico City has a plan for 100 LEAF taxis, while BYD electric sedans have plied the streets of Shenzhen China since December of 2011. Still, the project in New York will test specific local logistical and economic challenges. Fast charging is integral to the project's outcome.

[23] Halliwell, John. "Electric Transportation Infrastructure Activities." Advanced Energy 2011. October 2011.

New York City taxis operate an average of 120 miles per shift, far beyond the range of a fully charged LEAF battery. Analysis by the NYC Mayor's Office of Long-Term Planning suggests that vehicles will have to be charged an average of 1-3 times per day (graph below and Appendix E-1):

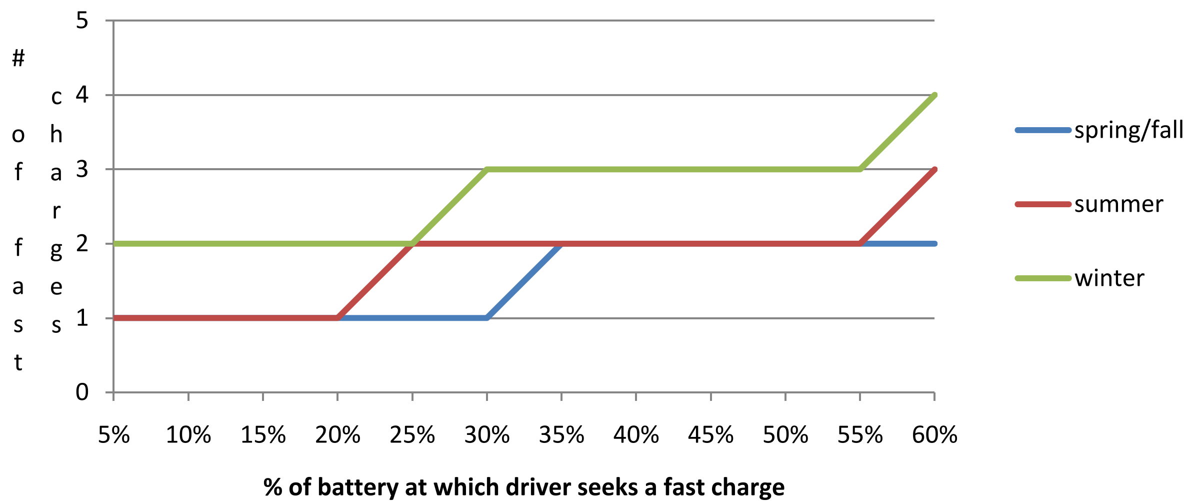

Figure 17: Charges Per Day as a Function of when a Driver Fast Charges[24]

This reliance on fast charging makes the convenient placement of chargers a paramount requirement. This has benefits for non-taxi users as well, since their needs are similar. Cabs travel the most congested streets in the City. 90 percent of trips occur in Manhattan.[25] Over 7 million vehicle miles are travelled on just less than 24 square miles.[26] Chargers placed on their behalf will likely be useful for other fleets and drivers, an assumption that will be tested as the taxi pilot begins this spring. Regardless, understanding how to install chargers in the most demanding, congested area makes any subsequent placements easier and may also provide a method for reducing operating costs.

Costs of real estate and electricity create obstacles as well. Few other parts of the country place such a premium on real estate and provide so little parking relative to the population. The average cost of an off-street parking spot in Midtown is over $530 per month. The hourly price often exceeds $15 per hour.[27] This creates a large opportunity cost for garage owners. The industry has installed over 92 AC level II chargers and seamlessly integrated them into its operations. In underground garages the chargers are wall mounted and the spots serve both electric and conventional vehicles. In comparison, a fast charger requires significantly more accommodation. It takes upwards of a quarter of a parking spot, and double that if a transformer is needed to increase supplied voltage. Consistently high levels of usage are needed to recover upfront costs and make up for the opportunity costs of dedicating a space. In fact, as the following section shows, it is not necessarily the upfront costs, but rather the ongoing ones that make fast charging such a challenge, namely high demand charges. Though these electricity demand costs are greatest in New York they may be obstacles in other areas as well.

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[24] analysis by the NYC Mayor's Office of Long-term Planning
[25] Schaller, Bruce. New York City Taxicab Fact Book. March 2006
[26] NYMTC. Congestion Management Process. April 20120
[27] http://nyc.bestparking.com/index.php

6.2 Demand Charges in New York City

New York City's high demand charges stem from the realities of its grid. Its 80,000 miles of underground electric cable comprise the world's largest subterranean distribution system.[28] Demand charges pay for maintaining it. They cover the utility's fixed costs of providing a given level of power to a commercial customer. Think of a car as an analogy to the distribution system. Two cars—one more capable than the other—both may be able to travel 100 miles. However, only the more capable car could span that distance at a speed of 100 miles per hour.

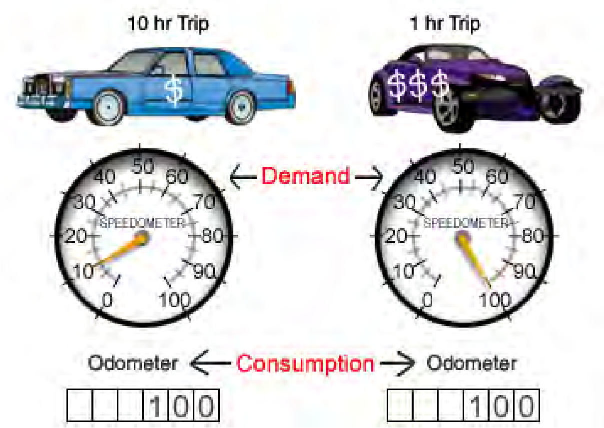

Figure 18: Illustration of how Demand Can Vary for the Same Amount of Power[29]

Demand charges pay for the grid requirements of fast consumption. They are most commonly priced on a monthly basis based on the highest amount of energy used (as measured in kilowatts). Under Con Edison's large commercial rate (S.C. 9) that demand charge varies between $17.50 and $22.60 per kW depending on the season and a facility's total power draw.[30] That has profound implications for appliances that intermittently use large amounts of power. In the case of a 50 kW fast charger, demand charges and related fees can exceed $1,100 per month.[31] To recoup those costs a provider would have to charge prices far higher than home charging. At $12 per fast charge (a 2-5x premium over home charging), it would take a provider 5.5 charges per day just to break even with respect to the demand charges. For a midtown garage it would take over 24 charges per month to break even when accounting for the opportunity cost of parking revenue (Appendix E-2). Neither of these calculations account for the upfront capital expense of hardware and installation. Without mitigating demand charges fast charging cannot stand on its own as a business. Absent exceptional utilization rates, the costs are too great. For taxis, operating costs per mile would likely be higher than today's more efficient gasoline powered vehicles.

This planning for fast charging in New York City illuminates a potential solution. Fast charging becomes much more economical if a charger does not create new demand. Demand is a function of a property's

[28] Ascher, Kate. The Works: Anatomy of a City. Penguin Press, 2005
[29] Illustration Courtesy of Think-Energy.net
[30] http://www.coned.com/rates/elec.asp
[31] Ibid.

overall energy profile. A fast charger has large impacts on a facility that uses little energy like, for example, a separately metered parking facility. Yet in large buildings energy demand far exceeds the 50 kW load of a fast charger. Many buildings in New York City have several megawatts of demand. Frequently that demand occurs for only a few hours a day. This energy profile from a Houston office building, though smaller than a typical New York City building, illustrates the point:

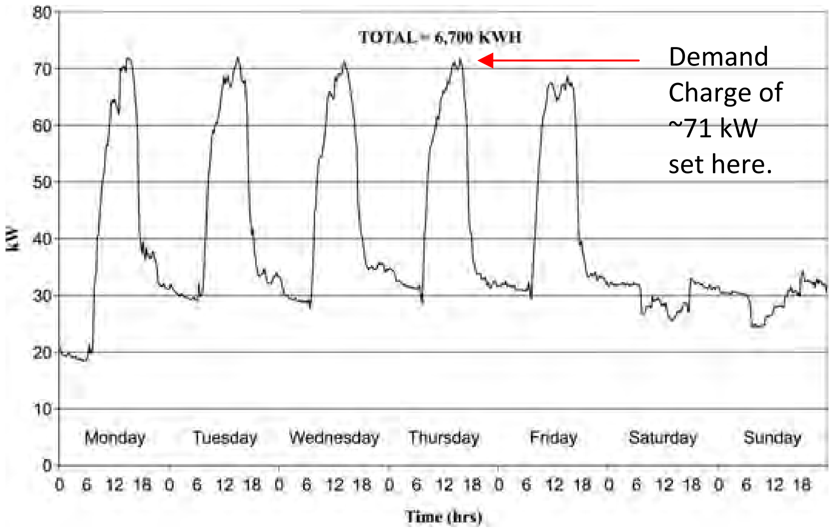

Figure 19: Houston Office Building Energy Profile with Demand Charge of ~71 kW[32]

Other than weekday afternoons, fast charging will not add to peak load. Of course, it only takes one incident of a fast charger used during a peak period to create additional demand charges. Appendix E-3 shows how unmitigated fast charging increases costs for even a large energy user. While the likelihood of charging exactly on a peak decrease as energy use grows, it is not definitively eliminated. The City's experience asking garages to install fast chargers for the electric taxi pilot suggests that fear of demand charges reduces interest in even a subsidized fast charger.

The ideal solution is to integrate with a building that has an advanced energy management system. The few times that fast charging does occur during a peak, the building may be able to turn off a fan or pump for the 20 to 30 minutes the fast charging is taking place. According to a building specialist and several energy management system (EMS) firms, there are many ways a building can reduce demand by 50 kW. In fact many participate in demand response, where they do that and more.

Unfortunately, few buildings have EMS's sophisticated enough to determine proximity to the building's peak load and shed load automatically. This technology, which would reduce operating costs of fast charging to just the marginal cost of electricity (~$.13/kWh), is uncommon.[33] Most lacking is the ability to actively monitor and shed load. Buildings with sophisticated systems and operationally suitable garages are fewer still. The City directly reached out to dozens of buildings, either through the managers

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[32] Bryant, John A. Short term energy monitoring: a road to long term energy savings? Facilities, Vol. 20 Iss: 10, pp.303 – 313

[33] Price based on Con Edison SC 9 Rate Structure

or their developers. Building energy management system firms have scoured their client lists as well. The market is not offering a way to mitigate the demand charges that fast charging creates.

6.3 Citywide Placement of Fast Chargers

Lessons from trying to place chargers in the core of the city inform and guide creating a master plan for installing chargers more broadly. Users need convenient locations, and property owners need a compelling business case. For users, convenience has to be balanced by the cost of charging. Property owners need consistently high-levels of demand to ensure that revenue will exceed the opportunity costs of using the real estate for other purposes. These requirements suggest that ideal locations will be near major arteries or gateways, high in amenities, with available property.

Nationwide, fast charging deployment seems to follow either this radial approach or a corridor strategy along specific routes. Oregon State and Connecticut are creating corridors. In the case of Connecticut, it is placing 10 regionally distributed fast chargers on highway rest stops throughout the state. [34] Oregon is electrifying its I-5 corridor and Solar City has done the same between Los Angeles and San Francisco. Meanwhile, eVgo, an initiative of the electrical utility and generating corporation NRG, is pursuing the radial approach. In its markets in Houston and Dallas it seeks to provide charging within the metropolitan areas. The models are not mutually exclusive and each has discrete benefits. Corridors serve long distance travelers, while metropolitan area strategies may better alleviate “range anxiety”.

Fast charging in urban centers may evolve to serve other needs. For example, fast charging may become useful for commercial users that do not want to size their batteries for rare, exceptionally high usage days. For them fast charging can be useful as an occasional way to extend their vehicles usability. Fast charge stations powered by distributed natural gas generators may also be a way to ensure EV functionality in a blackout. Batteries may also improve in durability and size to the point that fast charging serves as primary charging for EV drivers who park on the curb.

In the meantime, a study by the Japanese utility TEPCO illustrates that fast charging’s psychological benefits may be just as significant as their practical ones. Prior to the installation of fast chargers in the Tokyo area EV drivers would limit their travel to maximize battery charge. After fast charger installation, EV miles travelled increased seven fold.[35] The study’s sample is too small to be conclusive, but it indicates that fast charging may help increase EV adoption by reducing range anxiety. Certainly Tesla thinks so based on its investment in East and West Coast EV highways.

In order to be prepared for fast charge installation, the New York City Mayor’s Office, New York City Department of Transportation, and the New York Metropolitan Transportation Council worked together to identify potential fast charge zones. First, the team identified several regional areas that are promising fast charge locations.

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[34] April 5th, 2012 Conversation with Watson Collins, Business Development Manager, Northeast Utilities

[35] TEPCO Presentation. Takafumi Anegawa. EV-Charging Infrastructure Summit. London 12/1/2010. http://www.ev-charging-infrastructure.com/media/downloads/inline/takafumi-anegawa-tepco-9-10.1290788342.pdf

Location	Major Travel Route	Distance from Central Park (miles)	Driver Amenities	Available Property
Metropolitan Area Highway Rest Stations within New York State:				
Rockland County	Route 87, Ramapo Exit	34	Yes	Yes
Suffolk County	Long Island Expressway Eastbound, between Exit 51 & 52	43	Some. Visitor information, vending machines, bathrooms	Yes
Metropolitan Area Highway Rest Stations outside of New York State				
Cheesequake Travel Plaza	Garden State Parkway	42	Yes. Visitor information, restaurants, bathrooms	Not NYC or NYS owned
Major Transportation Hubs				
Ronkonkoma Train Station	Long Island Expressway, Exit 60	51	Yes. Nearby restaurants, cafes, and public bathrooms	Yes. Large parking structure
Stewart Airport	Route 87, Exit 17 & Route 84 Exit 7B	65	Limited. Public bathrooms and visitor information	Yes

Figure 20: Potential Regional Fast Charge Locations

Second, it identified properties that the City or its partners could leverage to install fast chargers. The City and Con Edison also own properties to potentially site fast chargers on. Appendix E-4 lists properties identified by New York City's Department of Citywide Administrative Services as electrically able to accommodate a fast charger.

The number of private facilities near major arteries that may appeal to existing or future EV drivers is too large to count. However, as mentioned earlier, while fast charging may have great value in spurring electric vehicle adoption, it may not stand on its own as a business proposition given its high supply costs and uncertain market demand. Yet, because fast charging may help induce EV demand by reducing range anxiety, the use of public property may ultimately be necessary for infrastructure installation. Below are borough level maps of City owned properties within ½ mile of major highway exits.[36]

Fast charging has value for vehicles travelling more daily miles than a vehicle's fully charged range. It may also have psychological value for drivers who do not exceed that range but worry they might. Currently the costs of providing fast charging a la carte are very high. The private sector may figure out ways to offer the service as part of a larger bundle, but if not the below maps may help the City provide locations for fast charging if necessary.

[36] Created by the Department of Transportation using data from the Department of City Planning

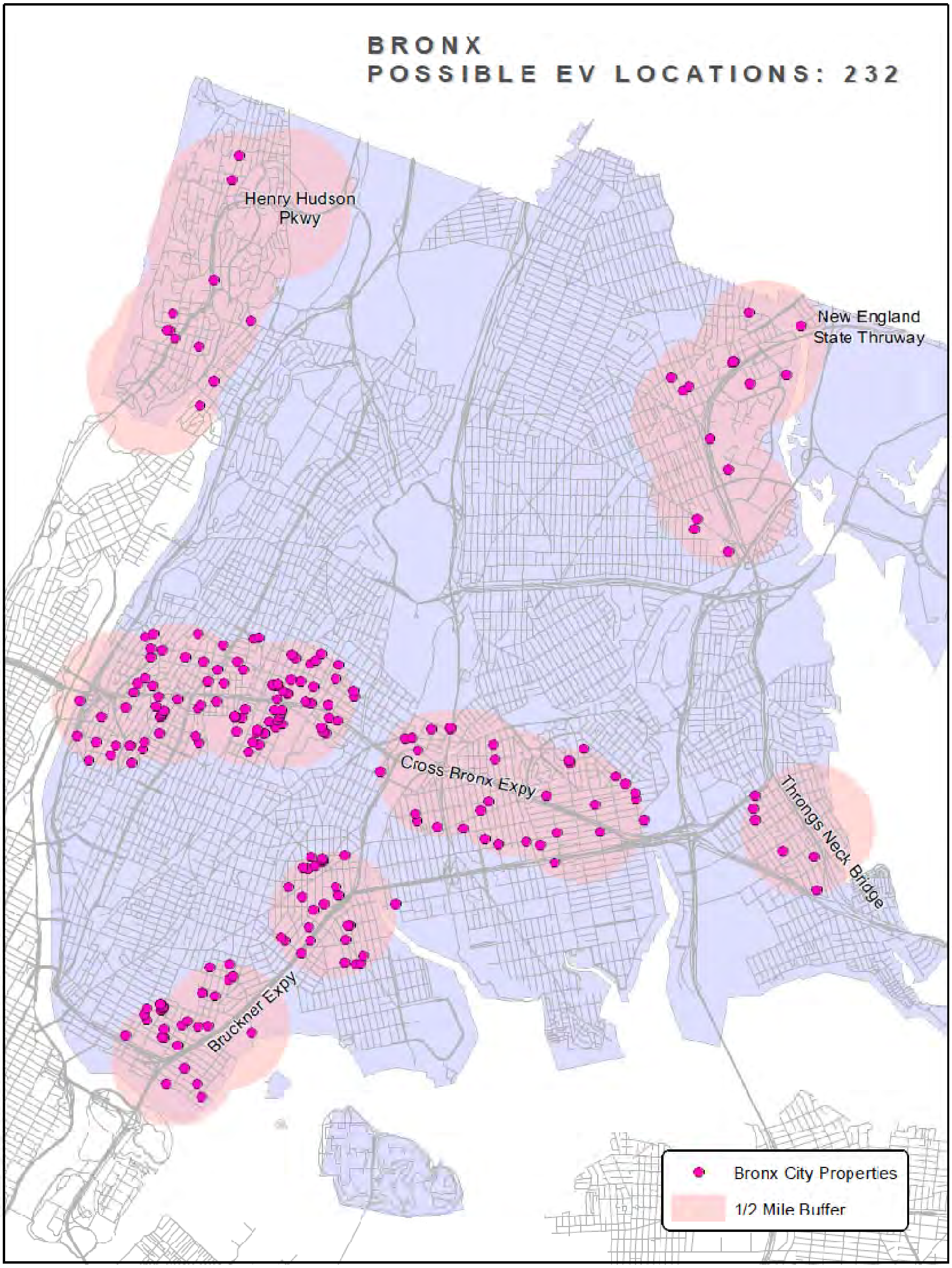

Figure 21: City Owned Bronx Properties within 1/2 Mile of Major Travel Arteries

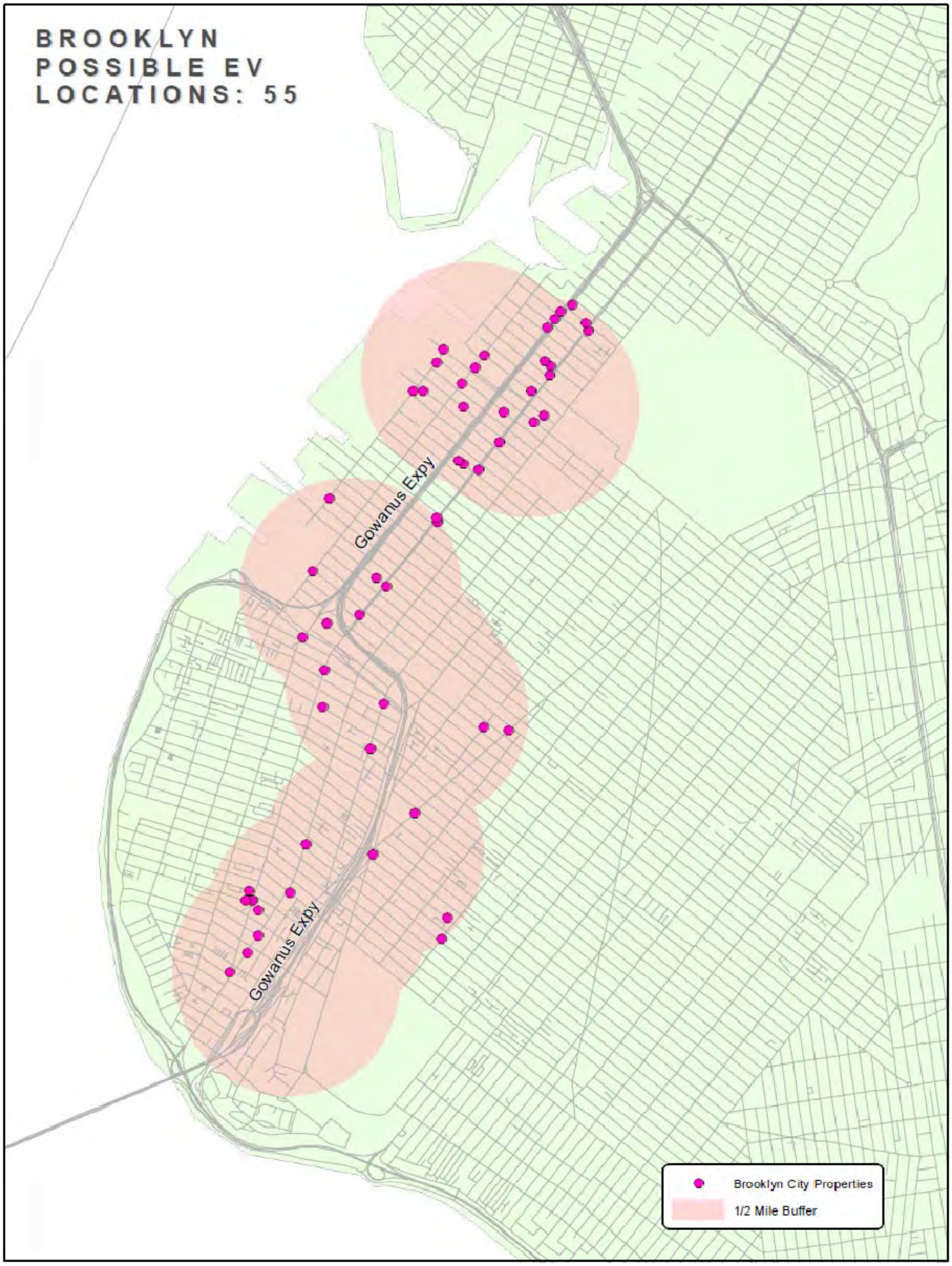

Figure 22: City Owned Brooklyn Properties within 1/2 Mile of Major Travel Arteries

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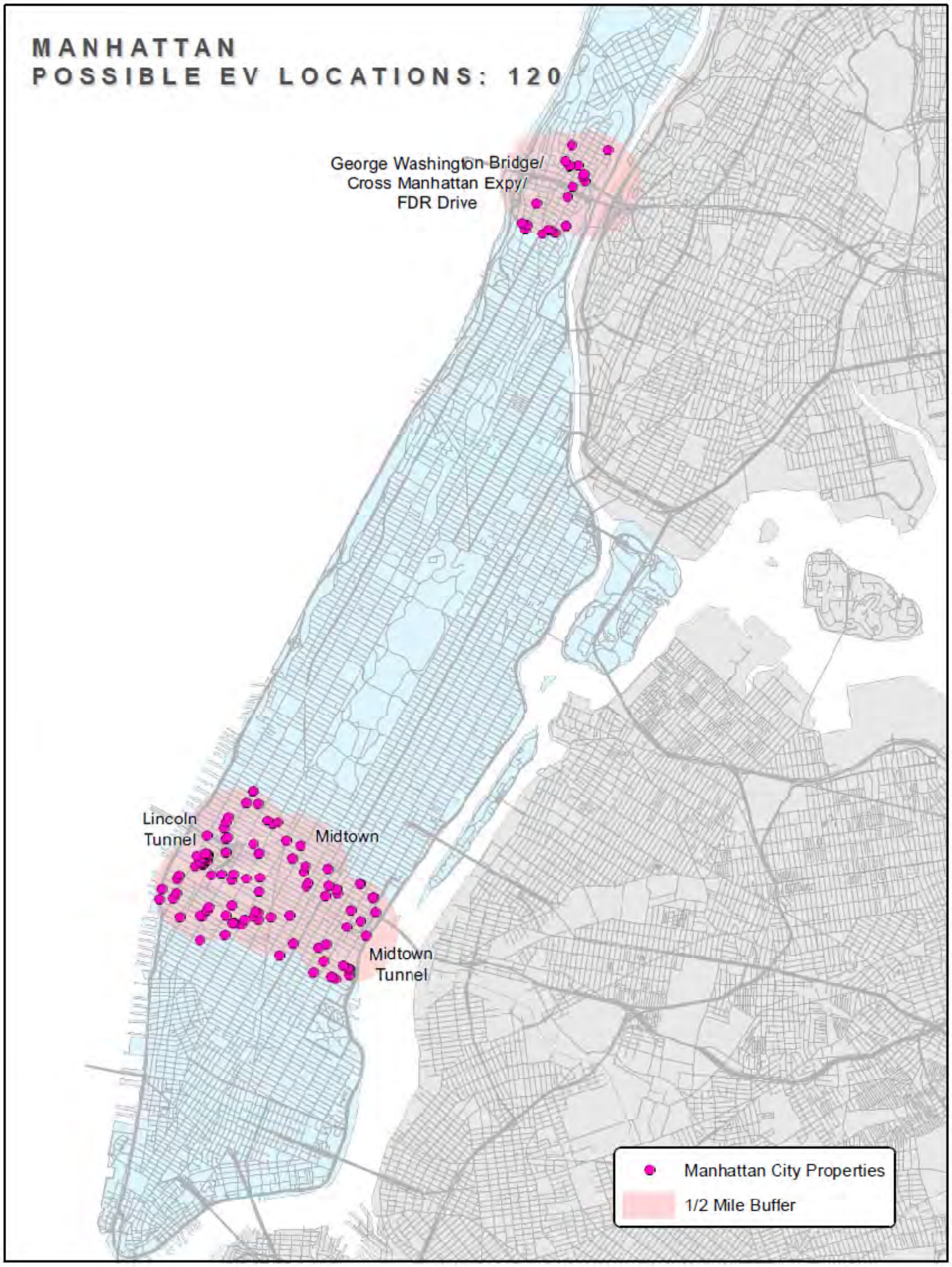

Figure 23: City Owned Manhattan Properties within 1/2 Mile of Major Travel Arteries

Figure 24: City Owned Queens Properties within 1/2 Mile of Major Travel Arteries

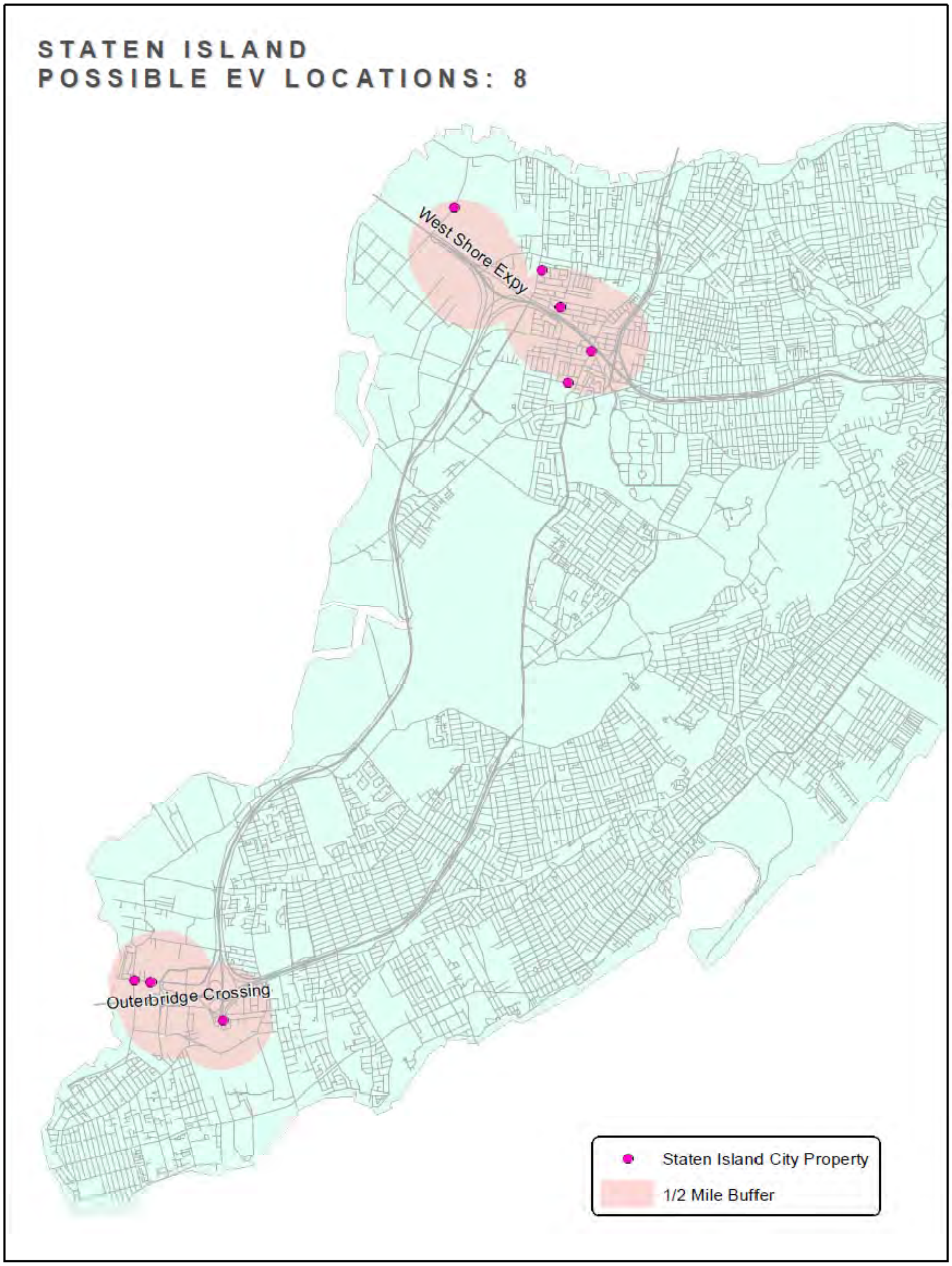

Figure 25: City Owned Staten Island Properties within 1/2 Mile of Major Travel Arteries

Improving Vehicle Economics

With the partial exception of fast charging, the previous section focuses primarily on the problems personal drivers face. This next section, which looks at three methods for improving EV economics, has benefits for commercial customers as well.

The first analysis, on EV car share compatibility, uses data from the City's pilot with Zipcar to determine how EVs would fair under real world usage. It shows that electric vehicles meet the needs for this particular City fleet well, even with high utilization. If vehicles are properly managed and/or paired with a small number of plug-in hybrids, EVs range does not necessarily limit their use. This analysis may help other cities as they encourage car share companies to increase their EV commitments. With this tool the car share companies and stakeholders can transparently understand whether EVs can operationally succeed.

Time of use electricity rates do not help increase utilization, but rather decrease the costs of operating an electric vehicle. New York City's standard residential rate of approximately \$.28 a kWh is one of the nation's highest. However, its off-peak rates are far cheaper. Allowing consumers access to these rates is good for the electricity grid and EV adoption. There are two initiatives outlined below; the first helps consumers install a 2nd electrical meter in their homes. The second is a ConEd pilot that allows a sub meter to separately measure an EV. This latter initiative may also have applications in commercial garages or even fleets. Though economic payback is not always the determining factor for consumers, it is meaningful. EVs do not have a long-term future without electricity's price advantage over gasoline. Local stakeholders support for EVs accessing to time of use electricity will improve the value proposition for EVs.

Commercial Charging: Pricing for Energy Used

The City worked with the New York State Public Service Commission (PSC) to clarify and improve how public charging is priced. Regulations prohibiting sub-metering or electricity resale caused EVSE providers to provide charging by time or at a fixed price, instead of by the amount of energy an EV consumed. This created uncertainty for providers and confusion for users.

In March 2012 the City spearheaded a coalition of EVSE manufacturers and charging providers that explained how these rules were counterproductive. Slower charging vehicles (3.3 kW) subsidized faster charging ones (6.6 kW). The coalition proposed new rules to allow electric vehicle charging to be priced based on the amount of energy consumed. In December the PSC responded with by allowing EV charging can be priced by the kWh, enabling the private sector to provide more charging at rates clearer to consumers.

Broadly speaking, vehicle to grid / vehicle to building technology allows the batteries in an electric vehicle to function like a temporary generator and supply power. In V2G the power is being supplied back to the larger electrical network. In V2B the power from the vehicle supplies power to the local building, either to help reduce its electric bill or to provide emergency power during an outage. In either case, the technology allows EV owners to reduce their electrical costs and perhaps even generate revenue. The City was particularly interested because it has the potential to grow its EV fleet into the thousands. It also consumes massive amounts of electricity. In 2011 the city government used over 4,300 gigawatt hours of energy.[37] The hope is that the City can be an early adopter of V2G/V2B and in so doing help develop the market. The initial economic and market analysis suggests the vehicle technology and regulations are not yet ready for a pilot. However, the City can take modest actions to make its charger infrastructure V2G/V2B ready.

These pieces of analysis suggest how young the EV market is. There are many steps and actions that can help make EVs more economically attractive. As the vehicles continue to improve and the understanding of how to maximize their value increases they will become more attractive relative to conventional vehicles.

[37] http://nytelecom.vo.llnwd.net/o15/agencies/planyc2030/pdf/greenhousegas_2012.pdf

7 Electric Vehicle Car Share

Car Share allows a driver to rent a vehicle by the hour by making a reservation online and tapping a card to a windshield. Unlike traditional car rental these cars are distributed throughout communities so that they can be conveniently rented for short trips. Companies like Zipcar, Hertz, and Enterprise all offer this service and tout its environmental benefits. Certainly it makes it easier for residents to access a car when needed without purchasing one, which lowers upfront costs but raises marginal ones, thus encouraging people to save money by driving less. By reducing ownership and potentially trips, car share helps reduce parking and driving congestion. The companies also tend to have new low polluting, high fuel efficiency vehicles.

However, until this point car share companies have been cautious about adding electric vehicles to their fleets. This is despite the fact that spreading the higher upfront cost of an EV among many users, as car share does, improves the economics of EV ownership. This lack of EV integration is unfortunate since adding EVs into car share would both reduce pollution and help expose New Yorkers to EVs. To better understand EV compatibility with car share New York City's Office of Long-Term Planning and the Mayor's Office of Operations analyzed trip data from the New York City Department of Transportation's (DoT) usage of car share for the first quarter of 2010 and created a tool that can be used to simulate electric vehicle usage for car share type scenarios.

The following analysis is two-part. The first part examines the overall characteristics of the DoT's vehicle usage and their compatibility with various types of electric vehicles. This portion of the analysis is a per-trip analysis that does not account for how state of charge changes over the course of a day. Still, it is useful in showing the potential benefits of electric drive. It finds that the Nissan LEAF would have meet 98 percent of all individual trips on an electric range and provided more than 5.3 tons of greenhouse gas emissions savings for the three months of analyzed data.

The second explains the results of a simulator that New York City created to test how electric vehicles would perform over the course of a day. Specifically, if vehicles were perfectly matched to each trip, how many trips could not be taken because of insufficient state of charge? Depending on the vehicle only an additional 4 to 5 out of over 580 trips, or less than 1 percent, would have been disqualified. Secondly, what would the battery charge be at the end of day? Because car share is also used by the public, the drivability at the end of the business day is important. In New York that is the prime weekday time for car share. Over a three month period there were between 2-12 days, again depending on vehicle, when three or more cars had a below 15 kWh charge.

The simulator has several limitations. The first limitation is that it matches trips ex post facto and makes decisions to maximize efficiency across the entire fleet. By failing to account for the potential EV drivers' and fleet operators' range anxiety it makes better matches than people would in real world situations. A second limitation is that the simulator models a homogenous fleet of only EVs rather than one that has both EV and conventional vehicles. This factor leads to overestimating the difficulty of incorporating EVs into a fleet. In most scenarios, longer trips could be taken with gasoline-powered vehicles, thereby optimizing usage for the electrics.

Despite these imperfections, the simulator shows that there is significant potential to incorporate EVs into this particular fleet. The City's analysis can help prove the benefits of electric vehicles. Furthermore, the simulator can be applied to other cities' or fleet's vehicle usage data to determine EV compatibility.

Overview of Issue

This EV fleet simulation project contributed towards the City's plans for electric vehicle implementation by determining the feasibility and benefits of electric vehicles using data from an existing car share program that is operated by the City's Department of Transportation (DoT). DoT started a pilot car share program with Zipcar in 2010 as a response to neighborhood concerns about the City's use of parking in dense commercial and residential zones. The program sought to reduce the department's parking footprint as well as improve efficiency and reduce costs.

The car share program provided many benefits. DoT's use of car share reduced parking in Lower Manhattan by 14 percent on weekdays and 68 percent on weekends. It also reduced overall vehicle usage.[38]

It also provided the City with a wealth of data on trip type and vehicle usage. This analysis examined that data and asked—if these same cars had been electric vehicles, how would they have performed? Issues included:

- Could battery-only electric vehicles meet the needs of individual trips and be charged sufficiently to meet a full day of use?
- Could plug-in hybrid and extended range electrics, which do not have operational constraints, deliver sufficient greenhouse gas and fuel saving benefits?

The Data

The car share program captured data on the vehicle use including the driver, vehicle, departure, return, total time, distance and many other variables for each trip. (See Appendix G-1 for the full list of original variables in data.) The initial stages of this analysis dealt with 661 complete records, 25 vehicles, and 18 car models, the most popular being the Nissan Altima Hybrid, Honda Civic, Honda Insight Hybrid, and the Toyota Prius. (See Appendix G-1 for full list of vehicles and MPGs.)

[38] New York City Department of Transportation. NYCDOT Car Share Pilot Evaluation: Results and Next Steps. Mayor's Management Council Briefing. June 2011

Basic Analysis and Results

The project focused on several key factors to determine if the data from the car share program would meet electric vehicle needs. The first was trip distances, a key factor in relation to electric range, which ranged from 1 to 128 miles per trip. The average distance for each trip was 29.3 miles, which would be within the total driving range of every EV, but there was considerable variance within the data, as evidenced by a standard deviation of over 17 miles (see Figure 26 below).

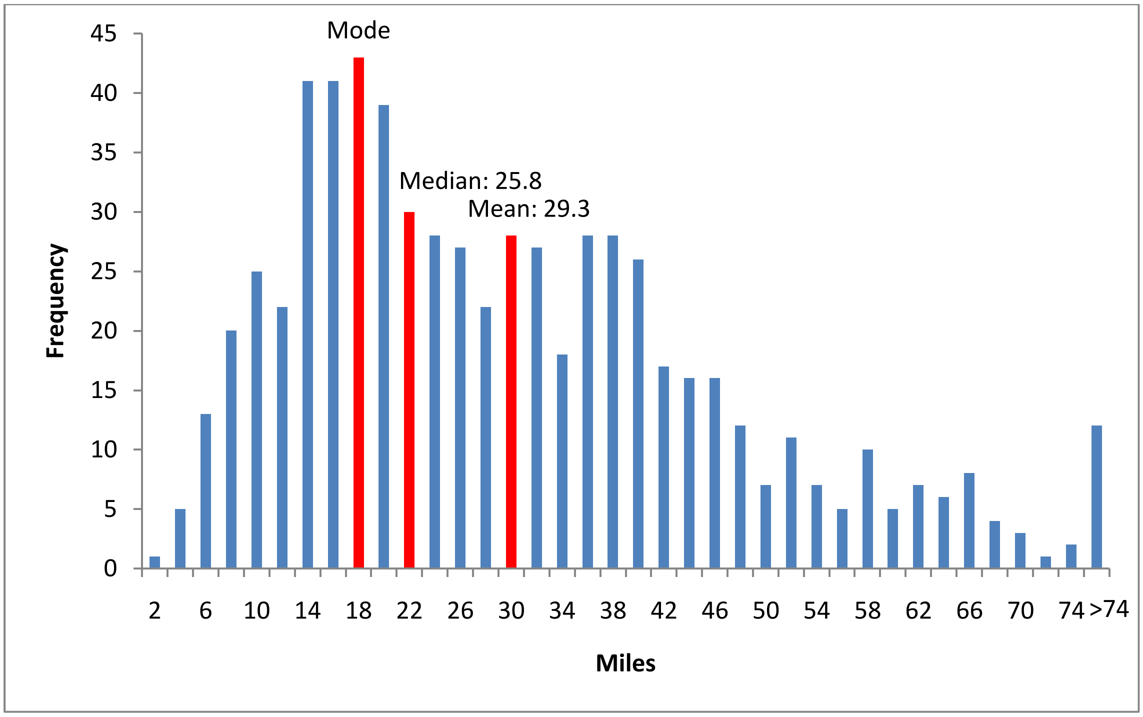

Figure 26: Histogram of Car Share Trip Distances

Vehicle	Electric Range	# Trips within Electric Range	Percent
LEAF	70	646	98%
Volt	35	441	67%
Prius Plug In	11	74	11%

Figure 27: Car Share Trips Meeting Electric Vehicle Requirements

Next, for the purposes of the analysis, three electric vehicles were chosen—the 2012 models of the Chevy Volt, Nissan LEAF, and the Toyota Prius Plug-in. These three vehicles were used throughout the analysis to test electric vehicle performance. When testing the distance of each trip against an electric vehicle on a full battery charge, it was determined that 98 percent of the trips would have met the LEAF's 70 mile electric range, 67 percent of the trips on a Volt, with an electric range of 35 miles, would have been electric-only, and 11 percent on the Prius would have met electric-only requirements (see Figure 27).

This analysis was on an individual trip level and, unlike later analysis, did not include the multiple trip scenarios that would reduce electric vehicles' overall state of charge and thereby their range.

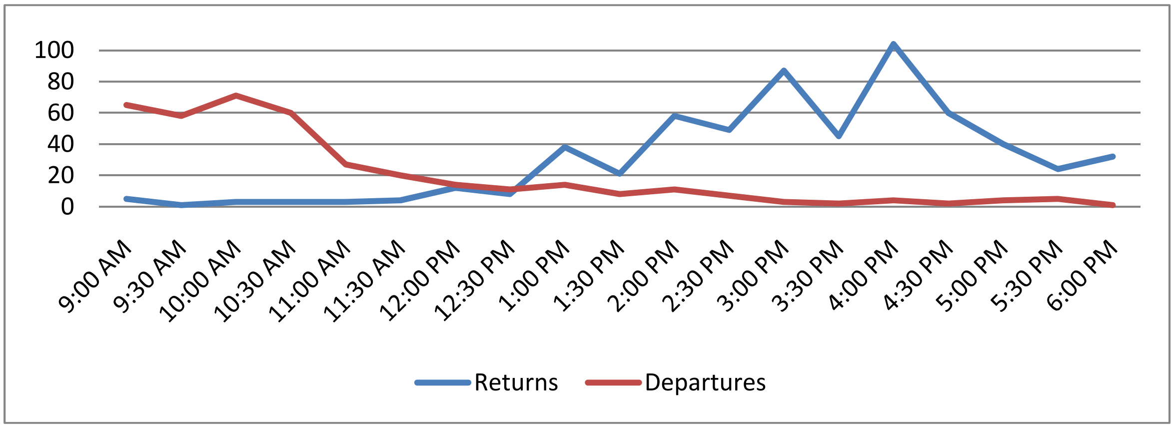

Figure 28: Time of Car Share Departures and Returns in Wall Street Zone

To better analyze the timing of trips, the data in the Wall Street/TriBeCa zone was isolated, as it had the most usage with 482 out of the 661 overall trips. It was determined that 87 percent of the cars were taken out before 12:30 (See Figure 29). Figure 30 plots the percentage of all the trips in the dataset that were in progress from 7 am to 7 pm. Car usage, the number of vehicles on trips, peaks at 12:30. Average trip length was 4 hours and 20 minutes.

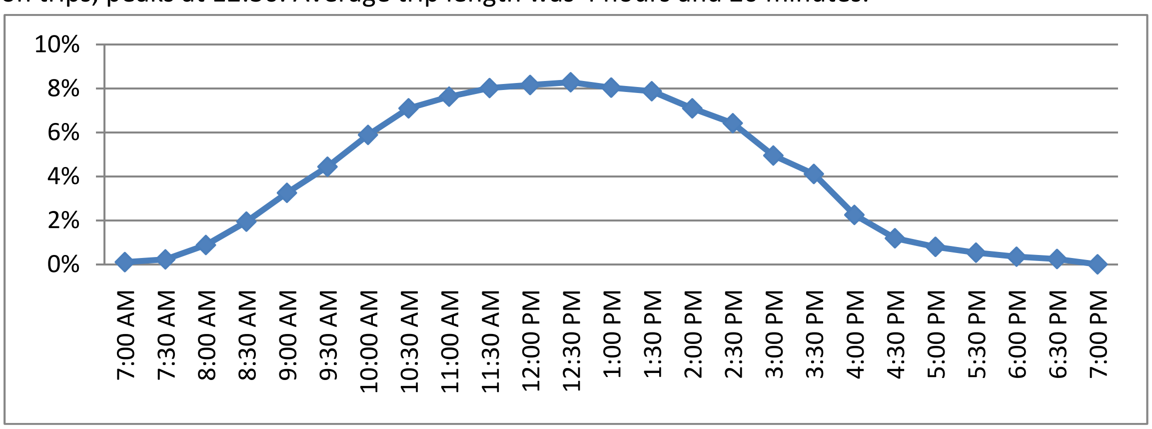

Figure 29: Total Car Share Trips by Time in Wall Street Zone

Greenhouse Gas Benefits

The next key factor was greenhouse gas emissions per trip. This was not included in the original data, but is derived from each vehicle's make and model.[39] This was then used to calculate the

[39] Vehicles were assumed to be 2010 model year vehicles.

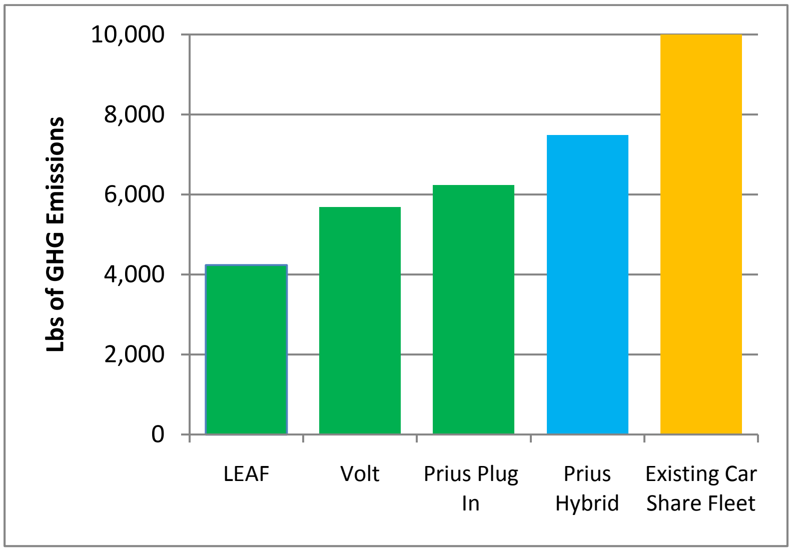

Figure 30: Total Emissions for Electric Vehicle Scenarios and Car Share Program

greenhouse gas emissions per trip using 19.35 lbs. of greenhouse gas emissions per gallon.[40] The total greenhouse gas emissions for all 661 trips from September to December of 2010 were 10.5 tons. Next, to determine savings from using an electric vehicle, each trip was run under the three electric vehicle scenarios (see Figure 30). For the gas back-up electric vehicles, the first miles of the trip were replaced with the car's electric range, with an emissions factor of .69 lbs of greenhouse gas emissions per kilowatt hour.[41] There were consistent greenhouse gas emissions savings under each electric vehicle scenario with the exception of one 72 mile trip where the gas Prius performed better than the Volt.[42] The lowest greenhouse gas emissions were under the Nissan LEAF, with a potential 5.3 tons in greenhouse gas savings, or almost half the emissions of the existing car share fleet.[43] These numbers are significant considering that most of the trips were already taken with high efficiency cars. On average all the electric vehicles examined outperform even a conventional Prius (50 mpg).

Creating the Model

For the analysis, a model and simulation was created in order to test the performance of potential electric vehicles in a more realistic situation where cars took multiple trips a day. The model limited the number of vehicles, assigned specific trips to each car, and will simulate the vehicle's performance as an electric vehicle and provide a summary of that performance on a daily basis.

For the initial pilot, Zipcar allocated an excess of vehicles to DoT. Consequently vehicles had low utilization rates. Constraining the number of vehicles in the simulation reveals whether vehicles will be able to charge enough in between trips to meet individual range needs. Identifying the

[40] City of New York, *Inventory of New York City Greenhouse Gas Emissions*. Sept 2010. Available at *http://www.nyc.gov/html/om/pdf/2010/pr412-10_report.pdf*

[41] City of New York, Inventory of New York City Greenhouse Gas Emissions. Sept 2010.

[42] When both the Prius and Volt are operating on gasoline, the former has better efficiency. Consequently for trips above a certain length the gas based efficiency becomes more impactful, to the Prius's advantage.

[43] this excludes the 2 percent of trips that did not meet the electric range

optimal number of vehicles entailed establishing a satisfactory out of stock rate. Specifically, from a cost benefit perspective, what is the appropriate number of vehicles? While fifteen vehicles would meet 100 percent of trips, those last marginal vehicles would often sit idle. Furthermore, real users have some elasticity of demand. Some of those marginal trips could be rescheduled or taken using other forms of transportation. In this case, it was determined that 12 vehicles, which would meet 97 percent of trips in the Wall Street / TriBeCa, struck the right balance between user needs and cost. The specific analytical methods can be examined in the main spreadsheet, but entailed use of several layers of COUNTIF Excel functions, the Solver tool, and conditional formatting of cells for graphical analysis (see Figure 31).

fx =COUNTIFS(master[ZONE],B3,master[Start Date Only],$A38,master[Start_Time Only],"<="&M$8,master[End Time Only],"> "&M$8)

	A	L	M	N	O	P	Q
8		11:00:00 AM	11:30:00 AM	12:00:00 PM	12:30:00 PM	1:00:00 PM	1:30:00 PM
36	10/29/2010	6	6	7	7	7	7
37	11/1/2010	1	2	2	2	3	3
38	11/3/2010	12	13	13	13	13	12
39	11/4/2010	5	5	5	5	5	5

Figure 31: Screenshot of Excel Model When Number of Trips Exceeds Car Availability

However, this only shows how many trips could be completed if state of charge and range *were not* limitations. Determining the 'state of charge' (SoC), or how much charge is available in the battery, over the course of the day requires an algorithm and scripting to "step through" each time period and assign a vehicle to each trip. Figure 32 shows the logic of that algorithm.

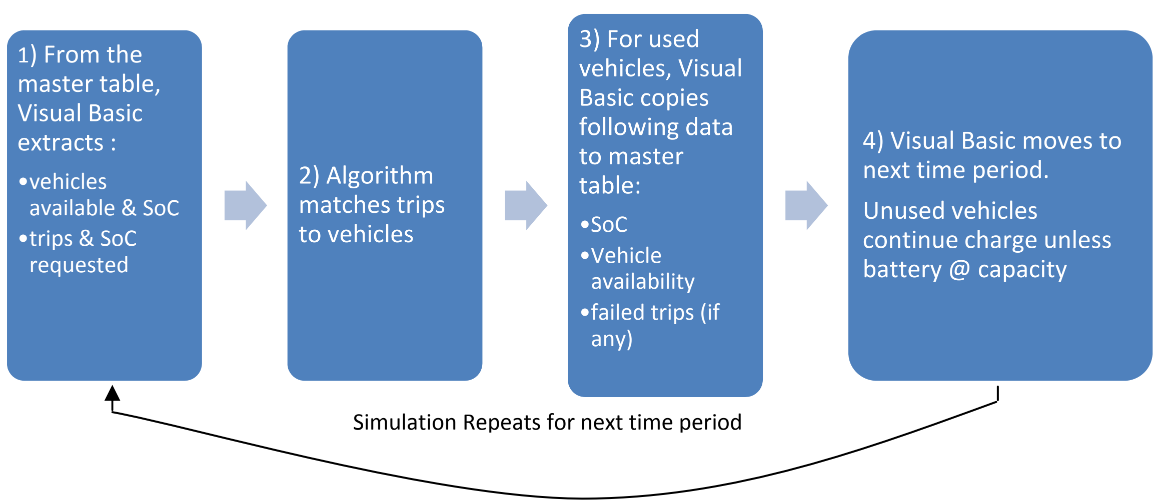

Figure 32: Car Share Simulation Model Logic

The algorithm employs a match that optimizes for the most efficient use of the vehicle. It also throws out trips that cannot be taken. First it matches the longest trip with a vehicle that has the minimum necessary charge. If no vehicle can match the trip, the trip is thrown out and recorded as a “failed trip”. The algorithm continues until all the trips are accounted for, either by being matched with available cars or by failing. Appendix G-2 includes an image of the matching table and descriptions of its features. Trips can fail for one of two reasons; either there aren’t enough vehicles available or the available vehicles have insufficient SoC.

Aside from number of trips, vehicle attributes determine that success or failure. Specifically: efficiency, battery size, and charge rate. Each of these draws from a separate, easily customizable vehicle table.[44]

Results & Implications

Four simulations were performed: A baseline, without any vehicle constraints and then with three different types of cars. The baseline measures how many trips fail in the model because of a lack of available vehicles. The vehicle models tested include the CODA sedan, the Nissan LEAF and the Ford Focus EV. Below are the results for each vehicle:

	Baseline	Ford Focus	Nissan LEAF	CODA sedan
Failed Trips	8	12	12	13
Days 3 or more vehicles have less than 15 kWh SoC	0	2	7	2

Figure 33: Table of Car Shar Trip Failures by EV Type

The one anomaly in the results is that the CODA has one more failed trip than the other two EVs, even though it has greater range. This is likely because the CODA was able to take a longer trip that made two subsequent trips impossible, either because of reduced range or because of lack of vehicle availability.

It also shows that the LEAF leaves the most vehicles with a depleted state of charge at the end of the day. This is likely primarily because the 2011 model is the only vehicle of the three that charges at just 3.3 kW, though reduced overall efficiency may also play a part. 2012 LEAFs will support 6.6 kW charging.

[44] www.cleancars.gov

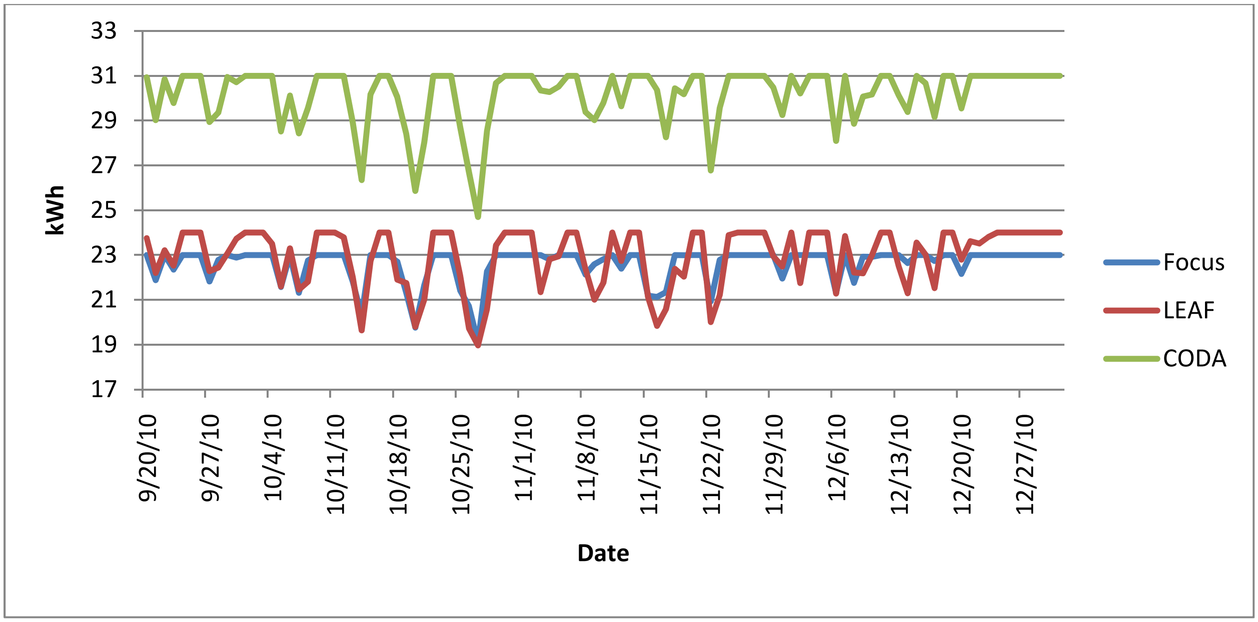

Figure 34: Average State of Charge @ 6:30 PM under Three Different Vehicle Simulations

These results are very promising. Out of 582 total trips, **only 1 percent would be disqualified due to a vehicle's SoC.** This is at worst 5 more trips than under the baseline scenario. Since DoT's usage is part of a larger car share program sufficient charge at the end of the day is also important. As the above graph shows, average end of day charge never dropped below approximately 80 percent.

This indicates that, for this particular fleet, electric vehicles would meet the needs of its drivers in a car share program with few modifications. It also shows that modest changes could make electric vehicles work even more seamlessly. A mixed fleet, which is beyond the scope of this simulation, would allow conventional or plug-in electrics to be used for the lengthiest trips. For example, a mix of 10 BEVs and 2 plug-in hybrids, used with optimal scheduling, would eliminate trips that could not be taken because of a BEVs limited range. The addition of fast charging could also further improve BEV performance.

New York City is expanding its usage of car and fleet sharing. Both programs generate data that can be analyzed using the tool created for this analysis. The tool can show which fleets are compatible with electric vehicles. Quantified data can put "range anxiety" to rest.

Ultimately this analysis of car share may be valuable for several reasons. First, finer-grained analysis and real world calibration will help the City gain comfort in electrifying more of its fleet. Second, it is further evidence to help persuade car share companies to add EVs to their fleets. The City will reach out to those firms in the hopes that they will help improve the functionality and user-friendliness of the current simulator. Finally, this assessment and information about electric vehicle performance may have considerable benefits to other cities across the country. The conclusions from this analysis can help reduce range anxiety for users and fleet managers and help policy makers understand the potential greenhouse gas emissions savings. As car share programs and cost-effective accessories or smart phones that capture vehicle data become more prevalent, this type of analysis can be replicated across the country and could provide powerful evidence for making EV implementation decisions.

8 Time of Use EV Metering

8.1 Overview

If you are a homeowner with a driveway or private garage, New York has one of the nation's easiest processes for installing a charger. In fact, a charger is treated just like any other electrical appliance and can be provisionally permitted and installed the same day. An electrician merely needs to e-file for a permit with the Department of Buildings.[45] The charger can then be provisionally installed, which is to say that it can be used by the homeowner while it awaits inspection and permanent approval by a Department of Buildings inspector.

Despite the ease of installing a charger, owners still have challenges accessing the cheapest electricity prices. Electricity has traditionally been sold to residential users at a flat rate. The cost of a kilowatt is the same at 2pm in the afternoon as it is at midnight, even though the cost of generating and distributing the former is far greater than the latter. ConEd does make time of use rates available, where peak electricity costs more than off-peak, but the vast majority of home owners continue to use the traditional flat rate.

That flat rate may make sense for appliances such as cable boxes that draw energy regardless of the state of the grid and cannot easily shift consumption to late night hours. Other appliances, such as dishwashers or clothes dryers might benefit from off-peak rates. Yet of all these, electric vehicles are an especially good fit for overnight charging. First, they are quintessential smart grid appliances that can be easily scheduled to prioritize charging off-peak. The vehicles have this feature built in. Second, they require large and regular amounts of energy, a fact that has implications both for the grid and consumers. At the fastest residential charging speeds they can require as much power as a full single-family house.

It is in both the consumers & utility's interest for the vehicle to charge overnight. On a wholesale basis, the delivery of late-night power costs as little as 4 percent of the cost of daytime electricity.[46] At those prices, driving an EV costs less than half that of a hybrid. Furthermore, directing a car to charge overnight is easier than having other home appliances behave the same way since it designed for scheduled charging.

For the utility, it makes sense to shift demand to when power plants and distribution lines are underused. According to a past analysis by Con Edison (included in the City's 2010 market research study), today's grid can handle as much as 20 percent EV penetration if charging is primarily off-peak. Because the wholesale cost is lower and it minimizes stress on the grid, off-peak charging should be encouraged.

8.2 Additional Meter Variance

Unfortunately, until recently City regulations impeded this desirable behavior. They prohibited the installation of a 2nd meter in a home, a rule intended to discourage illegal subdividing. That

[45] http://www.nyc.gov/html/dob/html/development/efiling_faq.shtml
[46] A consumer's cost of electricity includes both delivery and generation. The latter varies on a daily basis.

made mutually beneficial overnight electricity rates unavailable to home owners unless they wanted to shift all their usage to time-of-use pricing, a daunting option of uncertain value. To address this issue, in the fall of 2011 the Department of Buildings (DoB) has created a variance for electric vehicle owners. With proof of EV or charger ownership, DoB will allow homeowners to install a 2nd meter and make use of that cheaper overnight electricity.

Customized Sub-Meter

Meanwhile, ConEd is piloting technology that can measure a home on a flat rate and an electric vehicle at a time of use rate, without the need for a second meter. This meter and sub-meter combination has all the benefits of a 2nd meter, with potentially lower installation and ongoing costs. A 2nd meter on a ToU rate makes overnight charging cheaper than using a flat rate, but it also creates new costs that reduce some of the benefit. For example, an electrician must do an installation that's more complicated and time consuming. Additionally ConEd bills all meters, even second meters, a fixed customer charge to cover maintenance and administrative costs. An EV dedicated sub-meter can access ToU rates without the hardware costs of a 2nd meter and is therefore the best available solution for making charging more affordable and better for the grid.

ConEd's new sub-meter utilizes two pieces of technology. One is a measuring device on the circuit serving the EV charger. The other is a 3G cellular modem. The meter records data from the measuring device via the circuit's electrical wiring. This data is then transmitted through the 3G cellular modem to a server. It allows a customer to track their vehicle energy usage.

Con Edison's EV Load Measuring Device used as part of its Time of Use pilot.

This measuring device allows a circuit's energy load to be measured separately from the home or facility's other electricity consumption.

Figure 35: Image of ToU Sub Meter Hardware

This gateway and more specific metering, especially if coupled with new rates, allows customers to make smarter energy decisions. Customers will have real time data on the costs of charging their vehicles and will be able to respond accordingly. The following section, written by Con Edison, describes the company's pilot to separately meter an electric vehicle.

8.3 Con Edison Description of Time of Use Pilot

Overview

Because the electric grid must be designed and built for peak energy consumption to ensure reliable service on even the hottest days of the year, many of our assets operate well below peak design thresholds during off-peak hours. To manage our grid more efficiently, we must implement strategies to flatten our load duration curve -- decreasing peak load and filling in the valleys. By coupling new smart grid technology with time-of-use (TOU) rate structures, we can encourage customers to charge electric vehicles (EVs) during off-peak times. This will help ensure that any new demand from electric vehicles requires a minimum of new distribution infrastructure or peak generation plants.

EVs introduce new challenges. In the future, if EV charging occurred primarily during peak hours, increased capacity and infrastructure could be required. Similarly, if EV chargers were located in a concentrated geographic area, additional electric facilities could be required, as well. To address these challenges, it is important to encourage charging options that would utilize electric infrastructure during off-peak hours.

While energy efficiency and demand response can help with peak shaving, the proper management of future EV load can provide us with an opportunity for better asset utilization. If we do not manage charging behavior, future EV load could contribute to "new" peaks that require the use of peak generation plants and affect the life of our transformers and feeder cables. Clustering of EV charging in certain New York City (NYC) and Westchester neighborhoods and charging patterns where everyone plugs in at the same time can be detrimental. However, with new technology and TOU price signals, we may achieve effective staggered, off-peak charging for EV load.

One tool to help induce more efficient, off-peak charging would be a measuring device that allows customers to elect TOU pricing for their EV charging usage. A strong price differential could encourage off-peak charging. Con Edison is implementing a pilot to test the acceptance of this technology and experimental TOU pricing scenarios that could lower a customer's electric bill for off-peak EV charging by up to 55 percent per kWhr, compared to the standard residential flat rate.

Background

Con Edison's EV customers currently fall within 4 charging categories:

1) Residential customers who charge their vehicles at home;
2) Residential customers in multi-family dwellings who charge their vehicles in monthly parking garages and lots;
3) Commercial customers who charge their own fleet vehicles; and
4) Visitors (transient customers) who charge their vehicles in daily parking garages and lots.

Each type of EV customer has a different level of price sensitivity and operational needs. In general though, it is believed that residential customers with dedicated parking are most likely to respond to the off-peak price signals that will optimize grid asset utilization. They are likely to park the car overnight in one spot. Level II charging can fill almost any fully depleted EV in an off-peak window.

Con Edison has been working with NYC government agencies and the New York State Public Service Commission (PSC) to give residential customers access to possible alternative TOU rate options, but there are technological hindrances to overcome.

TOU rates for an entire house benefit customers who can reduce their usage during peak hours or transfer more of their loads to off-peak hours to take advantage of lower off peak pricing. This creates too much downside risk for customers who may not be able to control all of their peak loads. In comparison, electric vehicle charging is simple to time shift and relatively convenient to schedule primarily off-peak.

Until this year, the NYC Department of Buildings (DOB) prohibited installing a second meter in a single family home in order to discourage illegal subletting. Provided that a homeowner can prove EV or charger ownership, the department now permits, at its discretion, the installation of a second meter. However, while it allows for the possibility to take advantage of TOU rates, the second meter introduces new fixed costs to the customer.

First, there are the electrician costs. An electrician may need to do considerable wiring at the customer's residence to accommodate a second service. Second, the customer would be billed an additional monthly "Customer Charge," a fixed charge that applies for delivery regardless of how much energy [kWhr] is used. These added expenses can adversely affect any savings gained by TOU rates, particularly for the extended range EVs that require a minimal amount of energy to charge a relatively small battery. However, it might make sense for fully electric vehicles, given the larger battery and greater electricity consumption. Regardless, it could significantly diminish the price advantage of charging off-peak.

In other parts of the country, such as California, it is economically advantageous to install a second meter because of the tiered-rate structure. A second meter with an EV-TOU rate works for customers that exceed their baseline allotment of energy every month while on the domestic rate. The cost of electricity rises as the customer uses more. The energy usage from charging an electric vehicle would likely put a customer into higher priced tiers, whereas using an EV-TOU rate with a second meter allows customers to charge at lower rates during off-peak night time hours. Con Edison does not offer a similarly tiered rate structure.

Con Edison is now working on smart grid technology that may eliminate the need for a second meter to take advantage of possible future TOU rates. This may make it less costly and more attractive for customers to charge their vehicles off-peak.

Residential EV Pilot Program

In June 2012, Con Edison initiated a residential EV pilot program to test the technology and customer interest in an energy gateway and an energy measuring device called a load device controller (DC) in conjunction with a standard revenue grade meter in a system that is capable of separately measuring the EV energy consumption from the whole house. This technology could cost the homeowner up to 50 percent less than hiring an electrician. The monthly usage fee could likely be less than the monthly Customer Charge for a second separately-metered service.

The DC communicates over a home area network (HAN) via Zigbee[47] protocol to the energy gateway, and the gateway communicates to a data center via a cellular modem using a 3G network. While the initial pilot has the gateway embedded into the meter, the next generation will simply be hardwired into the customer's home.

During the pilot, customers can access a secure online portal through any web-enabled device and set up their EV charging profile to fit their charging habits and take advantage of possible future TOU rates. The customer also maintains the option of programming the timing of the charging directly from their vehicle. Through this portal, they may monitor their EV energy usage in near real-time. While the customer continues to receive their monthly bills based on their current service classification and meter reads, they will receive a "shadow bill". This means that their regular electric rate will remain in effect, but Con Edison will calculate several "what if" scenarios based on the data collected and possible TOU rate scenarios.

Of all the alternatives for measuring the energy consumption of the EV, a PSC-approved energy measuring device paired with an energy gateway, may provide the right balance between cost, simplicity and scalability. One other option is to require a second meter, but as previously explained this introduces high installation and ongoing costs.

Another option would be to utilize the meter within the EVSE[48] or charger itself. EVSEs are a nascent product with many makes and models. There may eventually be a standard by which EVSEs can communicate directly to the utility, but at this point they present a difficult and costly billing integration challenge.

Other Potential Applications

The DC paired with an energy gateway is affordable and flexible. It benefits not only EV homeowners, but also fleets and EV owners who park in multi-unit dwellings. For example, DCs can be placed on EV chargers for fleet vehicles, allowing fleet managers to easily:

1) Bill individual departments for energy consumption;
2) Manage the charging to minimize energy use and demand charges by staggering the charging during off-peak hours when the fleets are usually at home base;
3) Ensure vehicles have enough charge to complete their next shift.

The same concepts can be applied to parking garages in multi-unit dwellings. Garage operators could:

1) Bill tenants for their individual energy consumption;
2) Manage the charging to minimize energy use and demand charges by staggering the charging during off-peak hours, whenever possible;

[47] ZigBee is a communication standard often used for industrial and electrical equipment.
[48] As noted earlier, EVSE stands for electric vehicle supply equipment. EVSEs are commonly referred to as chargers. While EVSE is a more technically accurate descriptor, for readability purposes the two terms are used interchangeably.

3) Ensure vehicles are charged in time for their owners to use.

This would be an alternative technology to smart EVSEs.

The DC can even measure the generation of electricity from rooftop solar panels. One pilot participant has net metering for a rooftop photovoltaic (PV) array. Con Edison installed two DCs, one to measure the energy consumed by the EV and the other to measure the energy produced by the PV array. The customer's goal is to have a carbon-neutral motor vehicle. This technology will provide this customer with the data to determine if the energy from the solar panels offsets the energy used by the EV. Con Edison does not currently provide this information to the customer.

Challenges

The meters retrofitted with the gateway have been tested and approved by the PSC as revenue grade. The energy measuring device or DC has not been approved for revenue collection, but can still provide the utility, as well as customers, with valuable information.

There are three obstacles to this technology for TOU billing. First, integrating this technology into the existing billing system may be a challenge. Second, the DC and the stand-alone gateway are not currently approved by the PSC for billing. Finally, absent a PSC-approved billable device, there are no established rate structures to accommodate a single-meter customer having a hybrid flat and TOU rate.

Summary

The energy measuring device and gateway technology have the potential to provide a simple, economical way for Con Edison customers to take advantage of possible future TOU rates. We can eliminate the need for a second meter and minimize the associated upfront customer expenses and on-going monthly fees.

The technology allows for the collection of interval data from the customer's EV charging. Information gathered may be helpful in developing programs that influence customer behaviors, encouraging them to charge their EVs during off-peak hours and stagger their charging times. It can benefit the customer through lower off-peak pricing and the utility by flattening of the load duration curve and achieving greater asset utilization.

Con Edison's goal is to demonstrate the potential cost savings to customers for a single meter versus multiple meters, possible alternative TOU rate structures, and insight into customer behavioral issues associated with EV usage.

9 Vehicle to Grid / Vehicle to Building Technology

9.1 Overview

The City undertook this analysis to see if vehicle to grid or vehicle to building technology (V2G/V2B) could be technically viable in the relative near-term and increase the economic return of the City's expanding electric vehicle fleet. With 120 highway ready electrics, the City currently has the second largest public sector EV fleet in the nation, behind only the Federal government. Chevrolet Volts, Ford Transit Connects, and Navistar eStars are used across 12 agencies, including the Fire and Police Departments, Sanitation, and Parks. With so many EVs, the City is more likely than most other individual owners to have the ability to achieve the necessary scale to undertake V2G/V2B. Furthermore, New York City power is second only to Hawaii's in price, increasing the relative value of cost reductions that V2G may provide.

Figure 36: Example of one of the City's fleet electric vehicles

In the course of researching the topic, the City undertook a literature survey and interviews with key utility, private market, and regulatory stakeholders. Those include regulators at the New York Independent System Operator (NYISO), which administers New York State's energy markets, and PJM, which administers the transmission grid and markets in several other states. The City also interviewed its electricity provider, the New York Power Authority and its distribution utility, Con Edison.

As the following analysis shows, V2G/V2B technology is not viable for the City at the present time. First and foremost, the vehicle technology has not been commercialized. With the exception of some promising pilots it has not been brought to market. Second, even if the technology were readily available, the business case for the City would be tenuous. The majority of the City's fleet is in use during the afternoon when energy use in City facilities is at its peak and demand response or peak shaving would be most valuable.[49] Another potential revenue opportunity is the provision of a service called frequency regulation, which helps to maintain the quality of electricity on the grid and is most needed during the evening when the City's electric vehicles are likely to plug in. However, New York City's fleet does not currently have enough EVs to meet the minimum capacity for selling frequency regulation in the electricity market.

Though the short-term opportunities are limited, the City can undertake simple, "no regrets" measures now to prepare for potential technology in the future as it installs chargers, specifically by using wider gauge conduit. Installing larger conduit now has negligible cost but would allow for wider gauge, higher voltage wiring later, which would better enable V2G/V2B services and possibly other future advances in EV technology. The following is an in-depth analysis of the state of V2G/V2B technology and its potential for the city fleet.[50]

9.2 Description of V2B/V2G

With a potential fleet of nearly 5,000 EVs, the City is enticed by the potential to gain additional value from its EVs through the use of vehicle to building (V2B) and vehicle to grid (V2G) technology. After multiple discussions with experts, it appears that both V2B and V2G are technically feasible in pilot operations. The challenge however remains in building an effective and commercially viable model for both these technologies. Furthermore, neither of these technologies has been tested on a large scale and gaps are present regarding existing standards on communication and safety. In particular, standards governing reverse power flow of EV batteries to buildings and the gird are not yet available and would be necessary to enable V2B and V2G adoption.

The goal of V2B is to generate revenue by allowing the EV battery to release stored energy to "shave off" peak demands in building energy use. Offsetting peak energy would help to reduce costly demand charges—or the premium that a building pays for the guarantee of constant power supply. According to experts in EV technology, EVs, with their present battery capacity, may not be ideal for power demands that extend for long hours since long discharges would impact the effective range that an EV driver can use the vehicle.[51] They could, however, be used to provide power for shorter periods of time without substantially impacting the range.

V2B technology can be adopted by New York City if sufficient aggregation or EVs with large battery capacities can be plugged in to shave peak demands. The hurdles to overcome include:

1) net metering technology to measure the amount of power provided

[49] Peak shaving is a term to describe reducing peak electricity usage. As explained in the fast charge section, electricity is partially billed based on the highest 15 minutes of electricity usage, so reducing peak energy demand is a cost savings strategy.
[50] Special thanks to consultant John Ashish George who helped author this research.
[51] Vehicle-to-grid power fundamentals: Calculating capacity and net revenue by Willett Kempton and Jasna Tomić http://ac.els-cdn.com/S0378775305000352/1-s2.0-S0378775305000352-main.pdf?_tid=2562da1140caf6c7be47f4b5056f4d7d&acdnat=1336588812_0e191133d0eff22951d7495195aa06dc

2) sufficient power availability to address the duration of peak demands, and

3) vehicle connectivity coincident with periods of peak power demand

The goal of V2G technology is to use the EV battery to accommodate demand fluctuations or high frequency in the grid. Depending on the needs of the grid, power may be sent into or out of an EV's battery. Typically, there is a premium associated with providing these ancillary services. EV batteries could be suited to provide these services because they are typically needed for very short periods of time and require fast responses. Presently there is no large scale commercial project which can provide information on the commercial feasibility of this technology. PJM, in conjunction with the University of Delaware, is working on a research project that will provide more insights into the commercial feasibility of this technology. It could take two or more years before sufficient data has been collected.

Another concern is the lack of standards for V2G. These solutions cannot move beyond small pilots without a standard. The Electric Vehicles Standards Panel (EVSP) of the American National Standards Institute (ANSI) has identified a gap in using electric vehicles as a supply source in their Standardization Roadmap for Electric Vehicles. Standards for communication and safety aspects of this technology have been identified as a near-term priority by the panel with a timeline of 0 to 2 years to address this gap.[52]

Interviews suggest that vehicles can provide ancillary services today without having to feed energy back to the grid. As long as the rate of charge can be controlled, vehicles can be used for load control, frequency regulation and some forms of spinning reserves. These services would rely on enrolled vehicles predictably stopping charging in response to precise commands. If the vehicle is to participate in the "down" aspect of frequency regulation, wiring amperage and battery power output has to be increased. This suggests that building chargers with conduit sized for larger gauge wiring is a low-cost step New York City can take now to prepare for V2G. Running larger conduit now is low cost and may avoid expensive retrofitting later, particular in outdoor locations that require trenching.

According to a study by Navigant Consulting regarding the timeline for Electric Vehicle based power supply, V2B technology will precede V2G technology. V2B is expected to be commercially available before 2020 while V2G would follow in 2022.[53]

[52] STANDARDIZATION ROADMAP FOR ELECTRIC VEHICLES - Prepared by EVSP of ANSI http://publicaa.ansi.org/sites/apdl/evsp/ANSI_EVSP_Roadmap_April_2012.pdf

[53] PHEV/EV AND V2G IMPACTS AND VALUATION STUDY Presented by Navigant Consulting Inc. http://www.aps.com/_files/various/ResourceAlt/EV_Filing___Navigant_Study_-_April_2010.pdf

Projected V2G/V2B Timeline based on Interviews & Literature Surveys

Points of comparison	V2B	V2G
Timeline for commercial feasibility	3 - 5 years	5 - 10 years
Technology feasibility	The technology components are ready but the absence of standards, lack of vehicles with reverse power flow capability and sufficient levels of aggregation limit its adoption currently	The technology components are ready but the absence of standards, lack of vehicles with reverse power flow capability, insufficient levels of aggregation etc limit its adoption currently. Basic V2G through frequency regulation may be possible if sufficient aggregation is available. Technology for basic frequency regulation is available from limited suppliers
Potential hurdles to cross	SAE standards for Reverse Power Flow	SAE standards for Reverse Power Flow
	Aggregation necessary to provide sufficient power	High penetration of EVs in the city's fleet
	Availability of high power chargers capable of reverse power	Very large levels of aggregation necessary to compete in NYISO markets
	Availability of vehicles during peak demand	Availability of high power chargers capable of reverse power flow
	Availability of advanced energy management systems in buildings with features like demand response and net metering	Presence of EV aggregators in the electricity markets
	Islanding switches to built into building electrical systems	Reduced battery deterioration due to frequent charge/ discharge cycles on the battery
	Large battery capacity to provide sustained discharge for peak hours	Smart EVSEs with net metering capability
	Warranty from battery manufacturers to cover charge/ discharge cycles	Large battery capacity to realize larger revenues from ancillary services
	Buildings with wiring for 240V, 80A power flow	Warranty from battery manufacturers to cover charge/ discharge cycles
		Buildings with wiring for 240V, 80A power flow
		Saturation of ancillary services market could reduce the price premium currently available
		Technical complexity in coordinating supply from vehicles that are geographically dispersed
		Clear understanding of cost vs benefits on a large scale

Potential Benefits specific to V2B

Reduced Demand and Capacity Charges

If the City's EVs were available to be plugged in during peak periods they could theoretically provide power to buildings and therefore reduce demand charges. The vehicles would need to be aggregated close to the buildings that they provide power to. Aggregation of vehicles across widely dispersed parking lots may not currently work for V2B technology.

Demand Response

There are economic benefits associated with potential participation in demand response programs such as the NYISO SCR program or Con Edison's DLRP. However, ultimately, such participation will likely be limited in the same manner as peak shaving capability due to the operational characteristics of the City's EV fleet and the fact that DR programs are most likely to be called upon during peak periods.

Outage Management

Another potential benefit of V2B is the ability of an EV to act as an emergency backup for commercial buildings and facilities.[54] Such a system, where the vehicle's power is available to run basic operations in a house or a building for a short period of time, could help to aid in emergency preparedness.

Benefits specific to V2G

Revenue from ancillary services

The market for ancillary services is not as lucrative in New York as it is in New Jersey, Virginia and Ohio, which are part of the PJM market. According to a test of V2G system for energy Storage and frequency regulation in the PJM territory, the ten-year present value of V2G revenues for a 15 KW EV is around $30,000. A number of factors such as the type of service, market clearing price of the service and the duration of service were considered in the calculation. The diagram below shows that revenues are highest for the frequency regulation market and lower for spinning reserves.

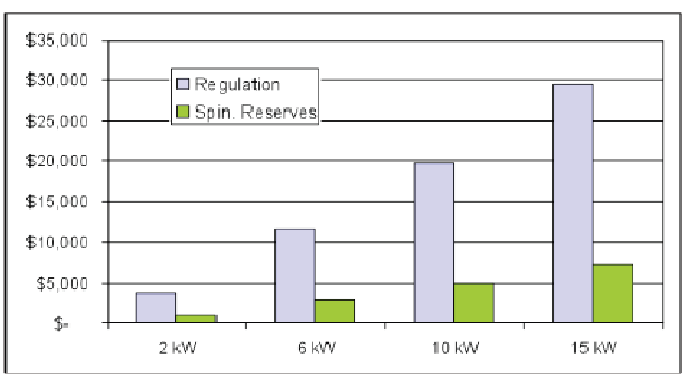

Figure 37: Graph from University of Delaware Study on PJM Market[55]

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[54] PHEVs as Dynamically Configurable Dispersed Energy Storage for V2B Uses in the Smart Grid by C. Pang, P. Dutta, S. Kim, M. Kezunovic, and I. Damnjanovic
http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=5715981

These values change depending on the price premium for these services in the markets that the EV participates. They could decrease if a large number of vehicles enter and saturate the market. These benefits would be smaller in New York City where the premium for regulation services and spinning reserves is much lower than the study's market. In NYISO, the prices for regulation services in a recent year varied between $7 and $21 per MWh in the Eastern corridor across the Day Ahead, RTC and Real Time markets. For 10 minute spinning reserves, last year, the prices varied between $0.99 and $12 across the same markets.[56] The difference in prices appears to be seasonal with prices for both frequency regulation and spinning reserves being highest in the July. This trend is common across the day ahead, RTC and real time markets. The lowest prices are in the winter months with February having among the lowest rates for these same services.

Assuming 16KW batteries that participate in the markets for 365 days and 24 hours, the returns per vehicle for frequency regulation varies from $2,894 to $8,682 over a 10-year period assuming a 10 percent hurdle rate. The same calculation for spinning reserves produced returns ranging from $405 to $4,958. It is clear that the economic benefits for the City's fleet are not as high as predicted in the PJM market.

9.4 Infrastructure Considerations

As the City considers V2B and V2G technologies, there are several infrastructure requirements that it must consider.

For V2G

Networked & Vehicle Aware EVSEs

Since vehicles will have to be connected into the grid, EVSE chargers must be able to control the charging/discharging of the battery. Since batteries can wear out with repeated charge and discharge cycles, it is essential that this operation is efficient. According to experts in V2G technology, *the depth of discharge* is a crucial element in determining the life of a battery. Studies have reported that a 3 percent cycle can achieve 10 times the lifetime kWh output.[57] These chargers need to be able to handle the signals from the ISO or the aggregator and charge or discharge the battery according to this signal. These chargers must also be equipped for two way power at 80A. Since the SAE J1772 standard for EV charging has 240V, 80A as the upper limit for Level 2 charging it is suggested that the EVSEs installed or at the very least their underlying infrastructure be capable of providing this power.[58] According to engineers of EVSE chargers, the typical EVSE chargers are configured for 30A, 40A, 70A and 80A. While only large trucks typically use chargers greater than 40A the maximum amperage is increasing for all

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[55] A Test of Vehicle-to-Grid (V2G) for Energy Storage and Frequency Regulation in the PJM System - Results from an Industry-University Research Partnership - Willett Kempton, Victor Udo, Ken Huber, Kevin Komara, Steve Letendre, Scott Baker, Doug Brunner & Nat Pearre http://www.udel.edu/V2G/resources/test-v2g-in-pjm-jan09.pdf

[56] Market Operation's Report - NYISO - Business Business Issues Committee Meeting Issues Committee Meeting May 16, 2012 http://www.nyiso.com/public/webdocs/committees/bic/meeting_materials/2012-05-16/Market_Operations_Report.pdf

[57] IBM SmartGrid Vision and Projects by Eleni Pratsini

[58] http://www.teslamotors.com/roadster/specs

vehicles. Passenger vehicles like the Tesla Roadster already support 70A.[59] These chargers also need to communicate with the vehicle's on-board equipment to determine the right level of charging for the vehicle. The adoption of standards for reverse power flow regarding communication and safety will address these needs. While estimating the economic benefits of V2G, we used a value of $5,600 as the cost per charger including the wiring cost as per a study conducted by the United States Postal Service on electrifying its fleet.[60]

For V2B

Demand Response systems with Net metering capability

To enable V2B to address the peak demands for a building, it is essential that the building be equipped with an energy management system that includes demand response facilities. Once a request is sent to the building to reduce its consumption, the building's energy management system can send a signal to the EV to provide V2B power. The EVs will continue to discharge their batteries and a net meter will monitor the amount of energy supplied so that the EV owner can be compensated accordingly.

Common for V2B and V2G

Wiring

The City needs to plan for 80A charging/ discharging facilities if it is to prepare its infrastructure for future V2B or V2G requirements. Since SAE J1772 allows for 80A Level 2 charging, the wiring and the breakers in the buildings would need to be capable of carrying this high power. Typically to carry 80A current through a wire, they are rated for 100A. Both these technologies will also require transfer switches to ensure that supply direction is maintained. As technology develops, hardware may be consolidated such that transfer switch attributes will be integrated into the EVSE and reduce the cost for maintaining supply direction.

Because that technology is not commercialized it is not yet possible for the City to estimate those costs. However, it is safe to assume that while V2G/V2B capability will cost more than a mere basic EVSE installation, some studies suggest, however, that such extra costs will be minimal.[61]

9.5 Standards

The Standardization Roadmap for Electric Vehicles published by the EVSP highlights some of the gaps in the standards for this industry. The prioritization for gaps are Near-Term (0-2 years), Mid-Term (2-5years) and Long-Term (5+ years).[62] The most important gap related to V2G is the use of vehicles as electrical supply. The report highlights the need to create standards for communication and safety for reverse power flow in V2G, V2H, V2L and V2V applications. This is highlighted as a gap that will require

[59] http://www.teslamotors.com/roadster/specs
[60] U. S. Postal Service - Electrification of Delivery Vehicles http://www.uspsoig.gov/FOIA_files/DA-WP-09-001.pdf
[61] U.S. Department of Energy Vehicle Technologies Program – Advanced Vehicle Testing Activity (Plug-in Hybrid Electric Vehicle Charging Infrastructure Review) by Kevin Morrow, Donald Karner, James Francfort http://avt.inl.gov/pdf/phev/phevInfrastructureReport08.pdf
[62] STANDARDIZATION ROADMAP FOR ELECTRIC VEHICLES - Prepared by EVSP of ANSI http://publicaa.ansi.org/sites/apdl/evsp/ANSI_EVSP_Roadmap_April_2012.pdf

revising SAE J2836/3, SAE J 2836/5, SAE J2847/3 and SAE J 2847/5 standards. The report states that infrastructure communication is not anticipated for V2H, V2L and V2V applications but may be required for advanced V2G functions when the EV serves as a Distributed Energy Resource (DER). The NEC standards are considered adequate for the EV serving as a standby system or a grid interactive system and the report does not anticipate any changes to these standards. This is a gap that has been prioritized as Near-Term and will require SAE and IEEE to work together to close it.

9.6 Battery Manufacturers & Market Outlook

Battery technology is the key driver of V2G/V2B potential. The depth of discharge of a battery has a bearing on the amount of energy a battery can generate through its lifetime. [63] As battery technology improves and deeper discharges can be accomplished with minimal wear, the potential economic benefits of V2B and V2G are likely to increase.

Improved battery technology may help to facilitate the V2G market, but it will also likely compete with it. Navigant Consulting estimates that stationary battery prices will be between $150 and $625 within the next 5 to 7 years. [64] At those prices, single purpose batteries will be cost-effective in the ancillary service market and would offer a competitive alternative to V2G. In that sense, the V2G/V2B market may be ephemeral, eclipsed by cheap always-available batteries. This uncertainty suggests that the City should apply a high discount rate in considering any potential investments in this technology.

9.7 Recommendations, Next Steps & Conclusion

As the City prepares itself for adopting a larger number of EVs into its fleet, the potential for V2B and V2G services to reduce the total cost of ownership will also likely improve. Our analysis suggests that V2B may be more feasible from a technical standpoint but less so from an economic standpoint since most vehicles are being used during the peak period of 2pm to 7pm. On the other hand, V2G could offer greater revenue potential since ancillary services are typically needed at night when the City's fleet vehicles are not in use. However this technology is not yet commercialized. Given this predicament, the City has two potential options to continue engagement with V2B/V2G:

Adopt a Pilot Program

The City could help to advance the technology of V2B / V2G by partnering with an academic institution or automobile company to undertake a research pilot aimed at assessing the infrastructure requirements, performance, and potential economic benefits of this technology. Such a pilot would affirm the City's commitment to clean energy technology and could be undertaken through the City's Municipal Entrepreneurial Testing Systems (METS) program, which enables companies to beta test their clean-tech products in municipal facilities.[65]

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[63] IBM SmartGrid Vision and Projects by Eleni Pratsini

[64] PHEV/EV AND V2G IMPACTS AND VALUATION STUDY Presented by Navigant Consulting Inc. http://www.aps.com/_files/various/ResourceAlt/EV_Filing___Navigant_Study_-_April_2010.pdf

[65] http://www.nyc.gov/html/gbee/html/initiatives/mets.shtml

Undertaking a V2B/V2G pilot would likely involve the following steps:

a. Issue a "request for expressions of interest" to signal to aggregators that the City is willing to be a technical partner. Find an EV manufacturer that is seeking to test V2B / V2G technologies

b. Include NYISO in discussions about carrying out a pilot phase with limited vehicles. Even a simulation would require access to frequency signals that are not publicly available

c. Ensure that the buildings and parking lots for the EVs are capable of transmitting high power at 80A. Since the standards accommodate until 80A it is likely that EVs in the future may require high power charging. The wiring and the EVSE units must be capable of handling this high power

d. Find a technical partner capable of furnishing smart EVSE units that can monitor the batteries' state of charge, charging rate, net charge transferred and vehicle authentication. While some of these topics still have gaps in standards, the EVSEs installed must be capable of communication with the vehicle and allow for reverse power flow

e. Ensure "buy-in" of fleet managers to the program so that the vehicles are plugged in whenever possible and so that impacts on operational needs are understood

Adopt a "wait and prepare" approach

According to experts at the University of Delaware, data collected in the next two years will significantly advance understanding of the potential for commercial V2G. The City of New York could decide to wait for these results and determine whether its fleet usage is compatible at a later date. In the meantime, the City could make its EV investments forward compatible by undertaking some simple, inexpensive steps while continuing to investigate the topic with regulators and technology experts.

To adopt this approach, the City would need to take the following steps:

a. Ensure that the buildings and parking lots that are retrofitted for EVs are capable of transmitting high power at 80A. Since the standards accommodate up to 80A it is likely that EVs in the future may require high power charging. The wiring or at least conduit must be capable of handling this high power

Select EVSEs and vehicles that are likely to be easier to retrofit for V2G purposes by having higher AC charge rates and DC fast charge connectors

b. Track the development of V2G technology and relevant regulations to ensure that the City is well positioned to pursue this technology in the future should a compelling opportunity arise.

Unfortunately neither the vehicle technology nor key market players such as aggregators have matured yet. In the meantime, building its infrastructure to be V2G/V2B ready will allow the City to become a participant when the market develops.

10 Conclusion

Over the past two years, New York has deepened previous electric vehicle research and analyzed entirely new facets of increasing electric vehicle adoption. It has made progress on the issues New Yorkers face, but the road to widespread adoption is still long. In order to have New York fulfill its potential as an EV market leader it must continue to make progress on increasing infrastructure, improving vehicle economics, and furthering education. These are policies that the City can implement on a local level.

In terms of infrastructure the City has made progress through three major projects. It has developed concrete plans for electrifying the curb. By first serving the smaller more lucrative food vendor market first it can create a cost-effective model for curbside vehicle charging. To increase off-street charging it has examined the possibility of requiring EV ready spots in new parking developments. By undertaking changes to the building code it has the potential to increase the number of chargers and charger ready locations by approximately 10,000 spots over the next five years. Finally, it has also mapped potential fast charge locations and identified the local barriers to making such chargers profitable.

The City also researched a wide variety of projects that have the potential to improve the economics of electric vehicles for consumers and fleets. Decreasing the cost of electricity is perhaps the most pressing. The City and ConEd worked together to allow the installation of a 2nd electricity meter, a stop gap measure that allows consumers to access cheaper time of use electricity. More promising is Con Edison's pilot that allows EVs to be billed separately using a new sub meter technology. That allows access to the more affordable rates with lower installation costs and potentially fewer monthly fixed costs. Electric vehicles may allow utilities to provide smart meters to users who are indeed eager to pay for the meter for the savings it can provide. For fleets, the City's analysis of its own car share usage shows that pure battery electric vehicles have more than enough range to cover even full days of fleet usage. This may allow the City to incorporate more pure battery electric vehicles, which can be cheaper than the plug-in hybrids it predominately buys now. Other fleets and cities can use the tool the City created, provided they capture basic information on vehicle usage.

To increase education and undertake public engagement, the City put into practice the results from its previous consumer research in the creation of the online social media platform Mission Electric. That project, which reached thousands of New Yorkers, increased learning on what types of communication energizes an EV-friendly audience and also what types of projects lend themselves to crowd-sourcing. Public-private partnerships with companies such as Duane Reade and Hertz brought additional attention to local electric vehicle investments and expanded the types of projects Mission Electric could bring to its audience.

Of course, there is much work to be done. Mission Electric would benefit from increased scale. The site itself would generate more energy and private involvement if it functioned in multiple cities. Meanwhile the growth in Facebook friends and high email readership suggests that there is a need for EV knowledge couched in a local, non-technical frame. Incorporating EVs into car share remains a goal, both to green those fleets and for the value exposure to EVs would have for New Yorkers. The City has many potential pilot projects borne from this year of planning. Those with the most immediate potential include a food vendor electrification pilot and the potential integration of EV readiness into the City's green building codes.

The City is creating solutions that are predominately borne out of its local context. For example, the availability of a test market of thousands of food vendors could help to shape policies and programs for curbside charging. Meanwhile, the lower cost of overnight electricity provides an opportunity to reduce the operating costs of EVs so the City and Con Edison are piloting methods to allow for differential pricing on single meters.

PlaNYC stands as a backdrop and an enabler for many of these actions. The City has a green codes task force and a process for engaging developers on environmental policy. Its own electric vehicle fleet is an outgrowth of PlaNYC goals to reduce citywide greenhouse gas emissions 30 percent by 2030 and City government emissions 30 percent by 2017.

This local strengths and circumstances have been paired with invaluable lessons from other regions and cities. Vancouver and Portland have helped shape New York's policy on charger infrastructure. Boston and Philadelphia collaborated on the creation of Mission Electric. The University of Delaware and Philadelphia are pioneering V2G/V2B analysis. The City hopes to be part of a continued collaboration with other cities and NGOs that seek to increase electric vehicle adoption.

Appendices

Appendix A Table of Figures

Appendix B Closed Loop Advisors Food Vendor Analysis

Prepared for:

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Energy Analysis of the Electrification of Food Carts and Trucks in New York City

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Date: November 27, 2012

Table of Contents

Executive Summary

The Mayor's Office of Long Term Planning and Sustainability in the City of New York is considering a pilot program to intermittently power food cart and truck generators from the electrical grid instead of from gasoline. This report explores the feasibility of such a pilot from the perspective of energy utilization of food cart and truck generators. This analysis is the first step in assessing the feasibility of a pilot.

Gasoline-powered generators are inefficient compared to power from New York City's regional electrical grid, and therefore consume more fuel and emit more greenhouse gases and other pollutants. The emissions of most concern are carbon dioxide (CO_2) and nitrogen oxide (NO_x). While CO_2 is known as the most pervasive greenhouse gas, NO_x penetrates deep into the lung to damage lung tissue, reduce lung function in susceptible populations (children, asthmatics, the elderly), worsen respiratory diseases, and aggravate existing heart conditions, causing premature death in extreme cases.

Findings suggest that generators aboard food carts and trucks can be powered from the grid with the exception of large generators (>7,000 watts). There is some gray area when it comes to medium-to-large sized generators, which the Energy Analysis section of this report covers in detail.

Two complementary studies were conducted to draw conclusions about generator energy use. The first looked at manufacturers' generator specifications and fuel usage data from several NYC mobile food vendors to assess their greenhouse gas impact and cost to operate compared to the grid. The second study, done in partnership with the Mayor's Office and NYC Service, involved canvassing mobile food vendors in various neighborhoods in three boroughs. This was necessary to achieve a better sense of the number of vendors using generators and the distribution of generator sizes. The sample revealed that 9 out of 10 vendors operate a cart and that 61% percent use a generator.

While carts comprise the majority of vendors, trucks have been growing in popularity in the past few years. Despite typically having larger generators than carts, we realized that a pilot may include trucks and that it was critical to determine the cutoff point for generator size.

The benefit of pollution reduction is clear. According to calculations of energy usage, if all mobile food vendors switched their source of generator power from gasoline to the grid, the CO_2 emissions reduction would be equivalent to removing 2,000 to 3,500 cars from the road for a year. This range was found by projecting the sample of vendors and generator sizes (150) to the universe of all licensed vendors (3,000), accounting for high and low scenarios.

Similarly, the projected reduction in NO_x emissions from switching vendors from generators to the grid would be equal to removing 9,500 to 11,100 cars from the road for a year.

Lastly, a study of the economic implications of switching generators from gasoline to grid power would yield annual fuel cost savings for the vendors we closely studied from $1,000 to $5,200. The potential economic and pollution-reduction benefits warrant exploring the operational feasibility of a pilot that would leverage existing infrastructure to supply power.

Introduction

Based on data we collected, the majority of mobile food vendors in New York City operate food carts and trucks that run gasoline generators to power electrical equipment (few run diesel). These generators emit pollutants that affect the air quality of the immediate area, add to the city's greenhouse gas emissions, and impact quality of life by producing noise pollution and unpleasant odors.

The purpose of this study is to allow New York City to do a preliminary evaluation of the environmental and operational potential of providing grid power to some subsection of mobile food vendors. Energy consumed by food cart and truck generators was compared with the estimated power supply capabilities of an electrical outlet fed by the grid.

Inspiration to investigate powering generators from the electrical grid instead of gasoline or diesel came from the sections of PlaNYC related to Air Quality and Climate Change. This study and any tangible results it may inspire are not explicitly listed as PlaNYC goals, but embody the spirit of the Plan.

Turning off generators located on or adjacent to busy sidewalks is similar to the idling goal within the PlaNYC Air Quality chapter. It would reduce local pollution emitted close to where people walk (and wait for food from street vendors). Powering these vendors from the grid rather than gasoline would reduce air pollution 80-98% and eliminate the local emissions where they operate.

Another concern was the need to provide infrastructure as cheaply as possible. Because vendors are mobile by nature, the City does not want to create a stranded asset. One option is to utilize existing wiring or conduit to light poles. In this scenario the outlet would either be attached to the pole or a nearby "bollard" built exclusively for the outlet. Another option is to create a new service. It is beyond the scope of this study to recommend which method to pursue.

The basis for investigation was the per-unit (e.g. gallon, kilowatt hour (kWh)) analysis of energy consumption from generator specifications and more importantly, from studying data collected from four food vendors - Wafels & Dinges, The Cinnamon Snail, FoodFreaks!, and Kelvin Natural Slush - that graciously volunteered for the study. Context about their operations were gained through phone interviews and on-site visits. Lastly, it was necessary to arrive at an apples-to-apples energy comparison of gasoline vs. grid power. This involved calculating the amount of grid power (in kWh) needed to supply the equivalent amount of electricity a gallon of gasoline would produce in a specific generator.

This report illustrates general insights gained from canvassing vendors, explains the analysis of energy consumption, emissions and economics of the generators used by the participating vendors, and concludes with a discussion and suggestions for further study.

Findings from this study are intended to inform the City's decision-makers on the energy constraints to consider when planning and launching a mobile food vendor electrification pilot.

Canvassing Vendors to Gather Additional Data

Assumptions, Boundaries, and Methodology:

To inform decision-making, high-level information was sought about generator use by mobile food vendors. Information from a sample of vendors provided context to support the energy analysis of specific vendors, including an estimate of the number of vendors that operate generators and among those, the distribution of generator size.

The question was posed of how to obtain this information. A survey was considered, but the logistics of administering a survey that would yield reliable results proved challenging. After thinking through the survey options another approach was chosen: to canvass vendors instead. Interns working for the City visited various neighborhoods of known food cart and truck vending and recorded observations about generators and visible electrical equipment.

Eleven neighborhoods were canvassed in Manhattan, Queens, and the Bronx. One hundred fifty observations were recorded, equaling 5% of the universe of NYC's 3,000 citywide and borough-specific permitted mobile food vendors.[2]

This canvassing study focused on geographic locations to capture the nomadic nature of food carts and trucks. Trucks may vend from two or more locations throughout the day. Carts are removed from place of business each day and reappear in the morning sometimes at a new location. The self-reported location of food carts is largely unavailable making food cart density in New York City very hard to predict.

Because canvassing every neighborhood in the five boroughs would be impractical, the most effective approach was to target specific areas given the time and resources available. Canvassers were sent to known areas of food cart concentration such as Midtown as well as areas assumed to have less concentrated food cart spots like neighborhoods in Queens and the Bronx.

Despite the geographic limits of the sample, the information gathered from the observations in the neighborhoods canvassed seems broadly applicable to NYC. For example, information collected about generator size is not affected by the location of the vendor. Electricity use is consistent across vendors that sell similar foods and use comparable cooking tools. While some vendors use more electricity for air conditioning, compressors, lights, advertising and other non-cooking related uses, these vendors are outliers and some of these heavy users are identified in our geographic sample.

Findings:

Setting out from downtown Manhattan, the City's five interns went as far north as Arthur Avenue in the Bronx and as far east as Queens Borough Hall. Given that geographic span, canvassing was focused more in Manhattan where vendors are known to be concentrated. The distribution of carts and trucks in our sample are mapped in **Figure 1** on the next page.

[2] While NYC grants 3,000 citywide and borough-specific mobile food vendor licenses, an unknown number of vendors operate illegally. It was outside the scope of this project to determine if the vendors canvassed possessed up-to-date licenses.

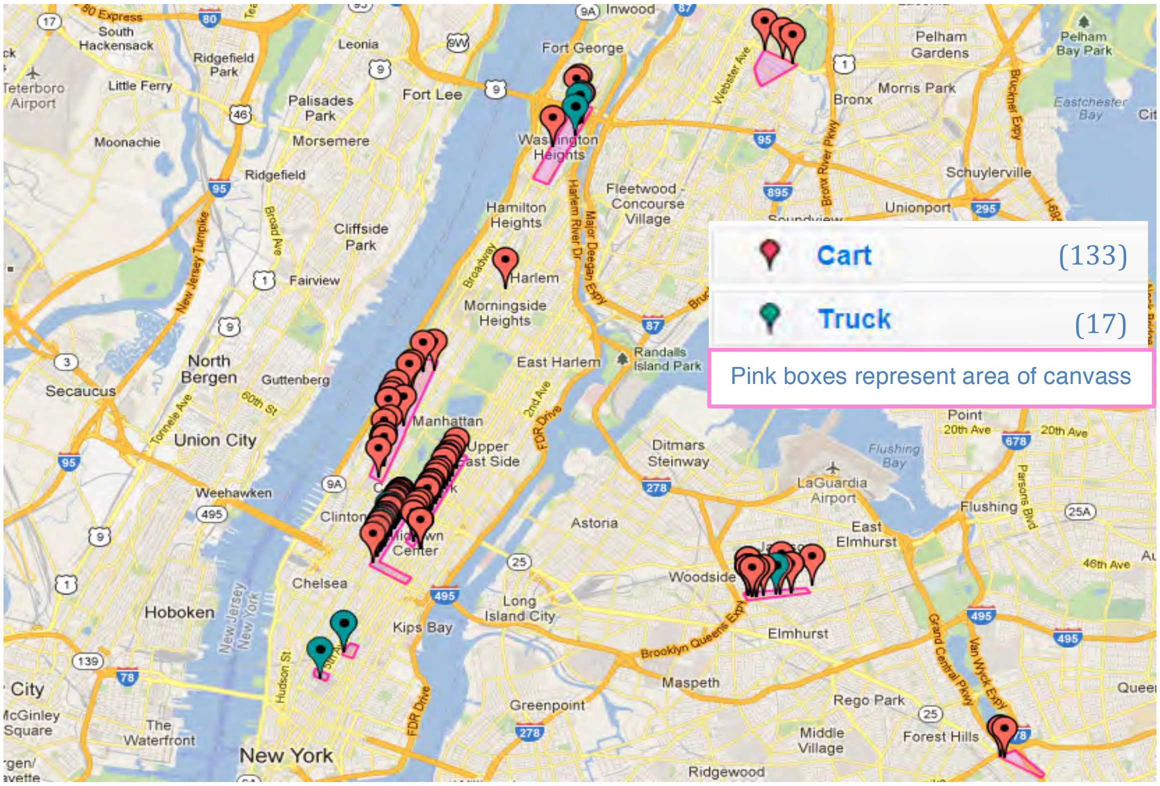

Figure 1: The distribution of carts and trucks canvassed illustrates the concentration of carts, particularly in Midtown Manhattan (east and west) comprising 89% of the sample.

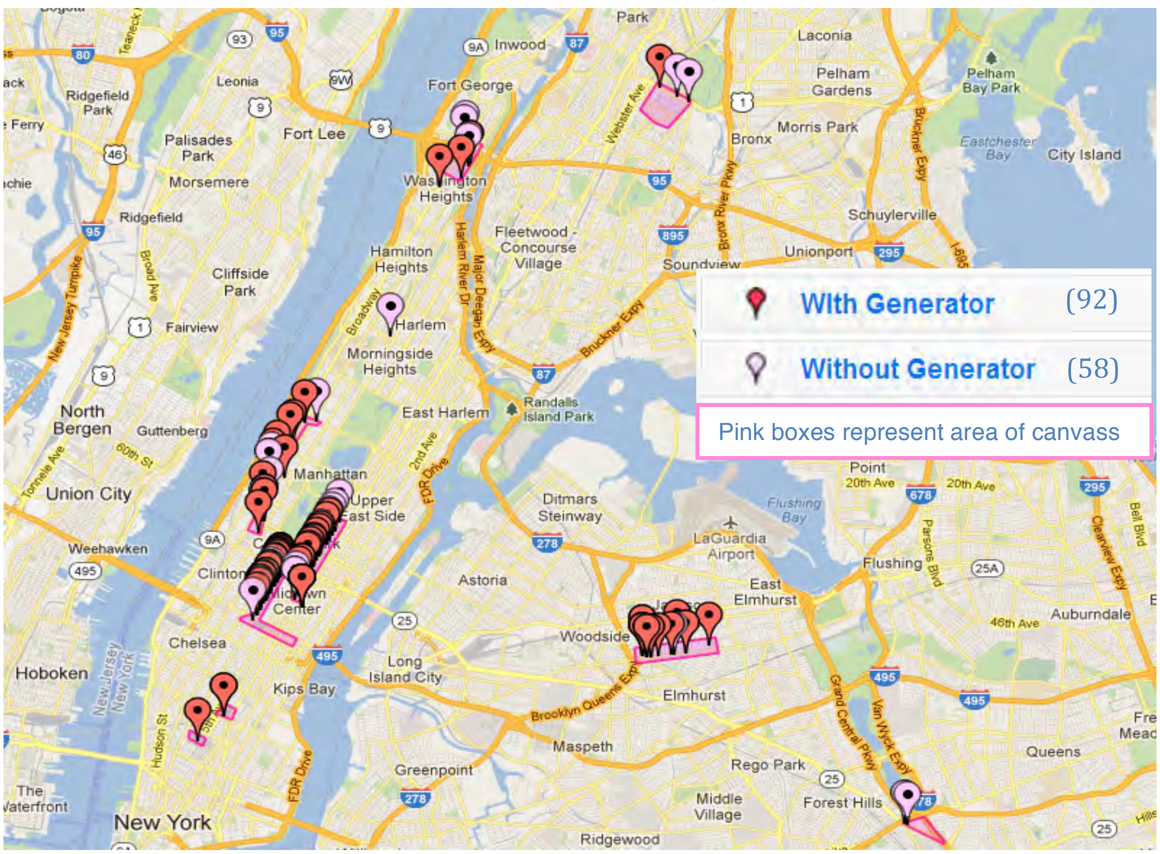

Figure 2: Distribution of mobile vendors (both carts and trucks) with or without generators within the area canvassed. 61% of all vendors in the sample had generators, including 58% of carts and 100% of trucks.

Canvassing was focused in Manhattan where vendors are known to be highly concentrated, which explains the geographic distribution of the sample shown in **Table 1**. The greatest number of observations was recorded in Midtown (east and west). The sample also revealed that nearly 89% (133 of 150) of observed vendors were operating carts (**Table 1**).

Borough	Carts	Trucks	Total Vendors
Bronx	3	0	3
Manhattan	107	16	123
Queens	23	1	24
Total	**133**	**17**	**150**

Table 1: Data collected about vendors during the canvass

The canvass study showed that of the 150 vendors observed, 58 did not have a generator (the red bar in **Figure 3**). That results in 39% of vendors captured in the sample without generators. The distribution of vendors with and without vendors is mapped in **Figure 2** on the previous page.

Given that 89% of the sample were vending from carts, it is no surprise that aside from not having a generator, the smaller 2,000, 1,000 and 3,000-watt generators were the most frequent size generators observed, respectively (**Figure 3**).

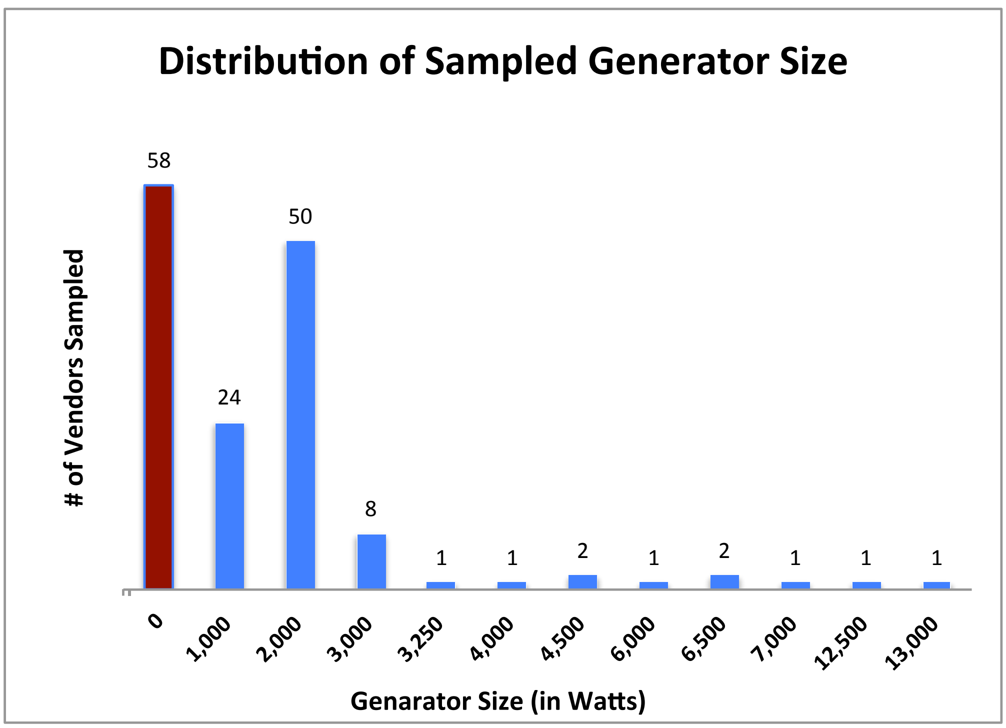

Figure 3: Data collected about vendors and their generators size during the canvass

Considering that only 8 of 92 vendors with a generator from the 150-vendor sample have a medium or large generator (from 4,500 watts and up), it is assumed that the vast majority of vendors in the full universe would draw less than 40 amps from the grid and therefore be eligible for a pilot or to participate in a grid energy program if a pilot were to be scaled.

Energy Analysis of Specific Vendors

Assumptions:

A pilot would provide electrical power to the curb in select locations. Using existing infrastructure such as light poles offers both opportunity and constraint. As alluded to in the Introduction, the opportunity is to avoid the cost of installing infrastructure by leveraging what already exists. The constraint is the amperage (amps) an electrical outlet would be capable of supplying in relation to the amount of amps a generator requires.

If light poles were to be used, the City indicates a maximum of 40 amps would be available at each point of grid plug-in. Exceeding 40 amps could be problematic for the vendor – they could pop a circuit breaker during a lunch or dinner rush and lose customers due to resulting delays in getting their electricity back up and running.

A good rule of thumb to follow is that the larger the generator, the more amps it's capable of supplying. Manufacturer specification sheets rate generator full load amp (FLA) levels by generator size. Based on specifications, a 5,000-watt generator would be the safest cut-off for generator size because its FLA is 41.7 (see the Methodology section for more details). However, a combination of on-site visits and discussions about electrical equipment used by vendors raised the possibility that generators larger than 5,000 watts operate below FLA. This hypothesis led to the inclusion of two food trucks with generators of 6,500 and 7,000 watts to measure if their average amp consumption approached or exceeded the threshold.

Boundaries:

As an extension of the assumptions above, The Kelvin Natural Slush truck was excluded from this study because their 13,500-watt generator and the equipment on the truck far exceed the threshold of 40 amps. Vending frozen food requires more energy-intensive equipment than any other food type. Kelvin requires a large generator to run condensers to produce their flavored ice, an air conditioner to keep the inside of the vending area cool in the summer, and additional equipment like freezers. They and other vendors selling similar frozen treats are exceptions due to the nature of preparing and preserving the food they vend.

Industrial electrical measurement devices were not used to inform this analysis. Such devices have data loggers to capture actual electricity output from generators and would be ideal to measure spikes in energy use, such as when equipment is turned on or during different times of day like the lunch or dinner rush. However, several reasons drove the decision against using such devices. First, most wiring setups observed during on-site visits and through additional research locate the main outlet the generator plugs into behind the generator. Complications arose because generators are typically placed inside a section of a cart or truck large enough for just the generator. From a logistics standpoint, connecting a measurement device would have been onerous, potentially time consuming, costly and inconvenient for the vendor. Second, safety of handling higher voltage wires would require the involvement of an electrician and associated cost. Lastly, a proper measurement device would cost in the range of several thousand dollars, which exceeded this study's budget.

Considering the analysis focused on electricity, equipment powered by propane gas was excluded. Examples of such equipment include but are not limited to griddles, deep fryers and coffee makers. The exclusion enables a pilot to be implemented at a minimum cost to the vendors since they would not be required to replace or purchase new equipment.

The scope of this investigation did not include conducting a full economic analysis (the cost of implementation are unknown at this stage) or determining the logistics of how to plug generators into circuits (e.g. distance, tripping hazards, preventing unauthorized use).

Particulate matter (PM) was excluded, as most generators observed did not run on diesel.

Methodology:

A combination of inputs informed the energy analysis: on-site information gathering of the energy profiles of equipment used by volunteering vendors, interviews with owners and operators, an interview with one food truck builder, records of fuel consumption, generator specification sheets, EPA regulations, The Inventory of New York City Greenhouse Gas Emissions, and regional grid and gasoline prices.

Generator size and energy intensity of the electrical equipment they power varies depending on food type and cart or truck size. A wide array of electrical equipment was observed on the carts or trucks studied and through observations of other vendors. The most commonly used equipment included lights, water pumps/heaters and refrigerators. Additional equipment types regularly encountered were freezers, speakers and vents (passive vents are another popular option). As noted with Kelvin, vendors of frozen treats (especially unpackaged treats), require much more electricity than others.

An interview of Jay Celona, the Director of Engineering and Design at Custom Mobile Food Equipment, helped inform this study's early stages. Mr. Celona's experience matching generator size with electricity needs provided background information of how vendors outfit their vehicles. Similarly, consultations with two electrical engineers validated early findings.

Generator size became the driver for choosing vendors to help with this study. Because Honda was by far the most common make of generator encountered (see the Canvassing section), specifications on Honda's website were used to determine FLA and run load amps (RLA) of generator sizes ranging from 2,000 to 6,500 watts. Both Wafels & Dinges and FoodFreaks! operate Honda generators, so those specifications were used for the 6,500-watt and 3,000-watt calculations and Cummins specifications were used for the 7,000-watt generator used by the Cinnamon Snail.

Honda specifications were compared to those of other manufacturers as part of the process for choosing a primary source for average generator performance (most manufacturers produce equivalent sized generators up to 7,000 watts). Performance in terms of amps and kWh were similar across manufacturers.

On-site visits were arranged during convenient times for vendors. These visits involved inspecting generators, assessing onboard electrical equipment, reading faceplates of electrical equipment, and interviewing operators about equipment usage (how often, hours of operation, etc.) and generator maintenance schedule. The maintenance schedule was discussed because regularly maintained equipment (oil and filter changes) operates more efficiently.

Measuring actual energy usage began with asking owners or managers to save receipts when filling up their generators. Some trucks have a shared fuel tank to operate both the truck engine and the generator. In such instances, it's necessary to isolate gasoline usage to move the truck versus to power the generator. A start and end odometer reading were taken to coincide with the period of receipt tracking to calculate average daily mileage. Multiplying the vehicle's estimated miles per gallon by the total miles travelled created an estimate for the fuel used for travel that could be subtracted from the total. The remaining usage was assumed to be for the generator.

Manufacturer specifications were used as the starting point to analyze generators of participating vendors. Specifications such as tank size were combined with the number of tank fill-ups, gallons purchased and both days and hours of operation. Other specifications such as output in kW were employed to estimate the electricity or kWh equivalent produced by each generator if it were to run on grid power rather than gasoline.

Figures from The Inventory of New York City Greenhouse Gas Emissions were used to determine pollutants and greenhouse gas emissions for the different power sources (kWh from the regional grid versus gasoline). NO_x emissions were calculated by using the emission profiles of the NYC region electricity providers. The analysis required a conversion of energy used per day by the gasoline generators into an equivalent amount of kWh.

Generally accepted standards (e.g. The Inventory of New York City Greenhouse Gas Emissions) allowed us to use pounds (lbs) of CO_2 per kWh to calculate the equivalent CO_2 emissions scenario if each volunteer vendor were to use grid-generated electricity instead of gasoline to fuel their generators. Similarly, gallons actually consumed by the generators studied and the lbs of CO_2 per gallon gasoline and diesel were used to calculate the associated amount of CO_2 emissions for each vendor.

Data from the canvassing of vendors (see pages 5-7) were used to project emissions for the universe of all mobile food vendors. It was estimated that roughly 1,700 - 2,000 of the 3,000 permitted vendors have generators. This range was calculated by multiplying the 61% of vendors in the sample of 150 vendors that had generators by 3,000. A certain amount of error was assumed, hence the range. The percentage of all vendors that operate carts was assumed to vary from 85% to 93%, based on the proportion in the sample comprised of carts (89% +/- 5% error). The median generator size for the sample set could be as much as 10% higher or lower than the entire population. To calculate emissions based on generator size, manufacturer specifications for the generators in our sample were applied to the daily duration of operation (8-13 hours based on information gathered from and about vendors).

Grid electricity emissions were subtracted from the equivalent gasoline-based emissions to calculate emissions avoided (based on NYC's Carbon Inventory). Lastly, data from NYSERDA was employed for regional gasoline prices and data from U.S. Bureau of Labor Statistics (BLS) was utilized for regional electricity prices. A 12-month average was applied to pricing to account for market fluctuations.

Energy Usage:

During on-site visits to participating vendors, faceplate data from the electrical equipment (freezers, refrigerators, lights, microwaves, etc.) was recorded. The sum of full load amps for each piece of equipment was immediately identified to exceed the amp capacity of the generator. This realization that some or all equipment ran at less than FLA led to the analysis of actual fuel consumption to estimate the electricity needs of each generator on an average day.

The simplest way to measure energy consumed by the generators studied was to have each vendor collect fuel receipts over a minimum of two weeks. Knowing the number of days in the period and the amount of fuel consumed enabled the calculation of average gallons used per day. A schedule of vendors' daily operations was created relying first on Facebook page updates and then using email if a question arose.

Contextual information such as average hours of operation per day and days per week were applied to gallons per day to derive the equivalent kWh per day based on the energy intensity of gasoline vs. the NY regional grid. **Figure 4** below shows the equivalent kWh used for the vendors studied. As expected, FoodFreaks!, with the smallest generator (3,000 watts) and least electrical equipment used the least electricity.

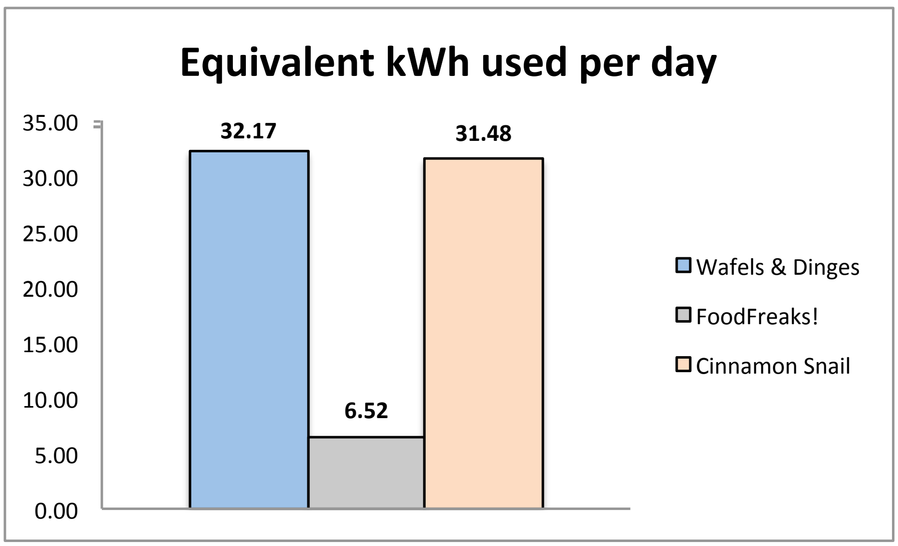

Figure 4: Calculations based on data collected from vendors

To put this in context, 32 kWh is enough to power an iPad for nearly 3 years.[1]

The division of kWh by the average daily hours of operation provides an estimate for average kilowatts, or kW. When converting kW into amps for the three vendors (applying the proper current and voltage), the average amp draw from the largest generator (7,000 watts) was estimated at 33. This suggests that generators larger than 5,000 watts may be able to participate in a pilot or scaled program. Inclusion should be conditional upon the equipment onboard and its use. Further study would be needed to make this determination.

[1] iPad energy usage is derived from an Electric Power Research Institute study that charged an iPad every other day for a year

Economics:

Based on 12 months of utility and fuel prices (through June 2012), on a per-unit basis, a gallon of gasoline or diesel is considerably more expensive than a kilowatt hour (kWh). Since the generators studied and observed were almost entirely fueled by gasoline, this section of the analysis was limited to comparing gasoline to kWh.

Equating gasoline to kWh is not a 1-to-1 comparison. As illustrated in **Table 2** below, depending on generator size (3,000, 6,500 and 7,000, respectively in the table), a gallon of gasoline produces the same amount of energy as nearly 6 kWh of electricity.

	# of kilowatt hour available per gallon of gasoline	Cost of available kilowatt hours per gal gasoline	Cost of 1 gal gasoline	Cost savings of switching from gasoline to grid power
FoodFreaks!	5.93	$ 1.15	$ 3.66	68%
Wafels & Dinges	5.74	$ 1.12	$ 3.66	69%
Cinnamon Snail	5.74	$ 1.12	$ 3.66	69%

Table 2: Cost analysis of equivalent amounts of gasoline and kWh; pricing from NYSERDA and U.S. Bureau of Labor Statistics

When the cost of 1 gallon of gasoline is compared to the cost of its electricity unit-equivalent of nearly 6 kWh, vendors could save almost 70% by switching to grid power instead of gasoline (**Table 2**).

An estimation of the average daily, weekly, monthly, and annual savings for each vendor was based on estimated hours of operations and days of operation per year. The projected annual savings are listed in **Table 3**. These figures represent the best estimates given accuracy of data available, particularly the hours of operation throughout the year. In addition, the estimated savings do not account for any service charges the City could chose to apply.

	Annual savings grid over gasoline
FoodFreaks!	$ 1,000
Wafels & Dinges	$ 5,200
Cinnamon Snail	$ 5,100

Table 3: Savings calculations based on cost analysis and data collected from vendors

Pollution Analysis

On a per unit basis, running electrical equipment on grid power has significantly less emissions than using either gasoline or diesel generators. This section compares CO_2, and NO_x generated by the three different power sources on a per-unit and annualized basis. The graphs illustrate the difference between sources and the benefits of running electrical equipment from the grid vs. generators. Emission factors were sourced from The Inventory of New York City Greenhouse Gas Emissions.

CO_2:

Pounds of CO_2 emitted per-unit of fuel consumed was analyzed first in order to arrive at the amount emitted by a specific vendor. Per-unit CO_2 emission figures for a gallon of gasoline or diesel were applied to each vendor's actual energy consumption and average daily hours of operation (adjustments were made for generator efficiency). CO_2 was then calculated for the amount of kWh required to supply the same amount of energy from the grid that the participating vendors consumed when burning gasoline in their generators.

Figure 5 displays the annualized CO_2 emissions for the participating vendors. These projected numbers are important to consider because they apply the average daily gallons of gasoline consumed, and the diesel and kWh equivalents specifically calculated for each vendor and their generator. Consumption is the driver of emissions. **Figure 5** illustrates this finding with the larger 7,000-watt generator of The Cinnamon Snail emitting less CO_2 than the smaller 6,500-watt generator operated by Wafels & Dinges.

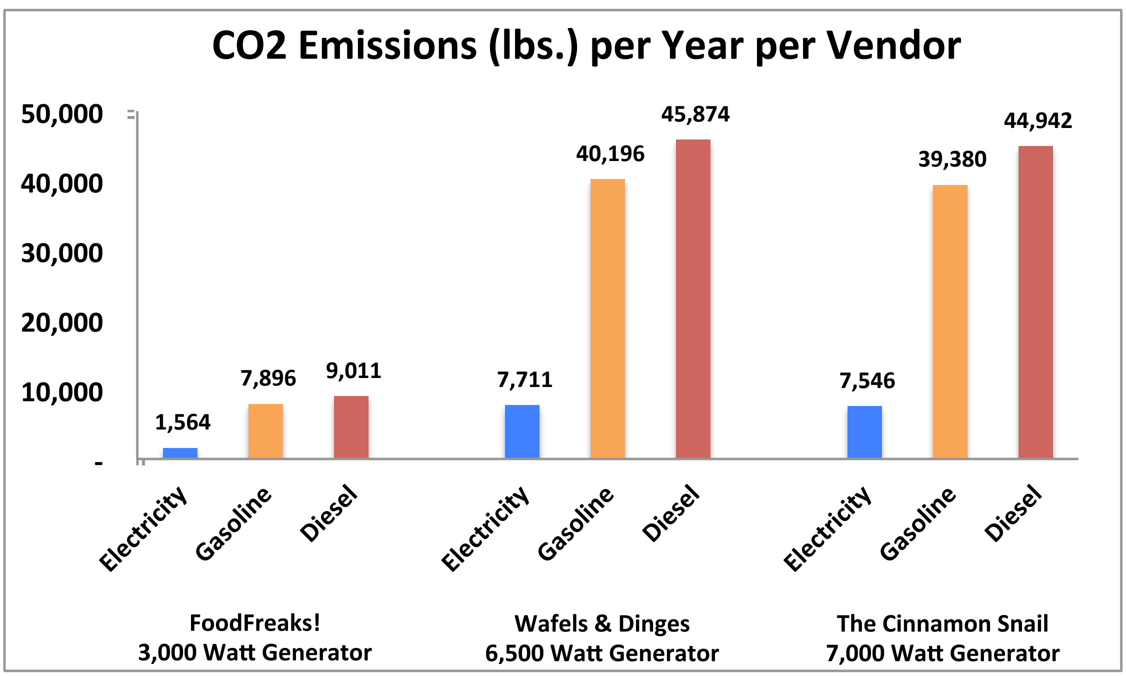

Figure 5: Projected annual emissions by source; Data from manufacturer specification sheets, collected from vendors, energy consumption calculations and The Inventory of New York City Greenhouse Gas Emissions

Under a pilot scenario, these yearly per-vendor projections would multiply depending on the number of vendors and the size and usage of their generators.

So what does this mean? If electricity replaced gasoline as the power source for generators in all permitted generator-using food carts and trucks in New York City, between 8,000 tons to 20,000 tons of annual CO_2 emissions could be avoided. The wide range was calculated based on low and high projection scenarios based on the sample. Determining factors are the actual number of generators and their size. The equivalents of avoided annual emissions are stopping use of 40-100 railcars of coal, or taking 2,000 to 3,500 cars off the road.

NO_x:

Analysis of NO_x emissions followed the same approach explained in the first paragraph of the section on CO_2.

Figure 6 displays the annualized NO_x emissions per vendor, projected in the same methodology as CO_2. As with CO_2 consumption is the driver of NO_x emissions. **Figure 6** illustrates this finding with the larger 7,000-watt generator of The Cinnamon Snail emitting less NO_x than the smaller 6,500-watt generator operated by Wafels & Dinges.

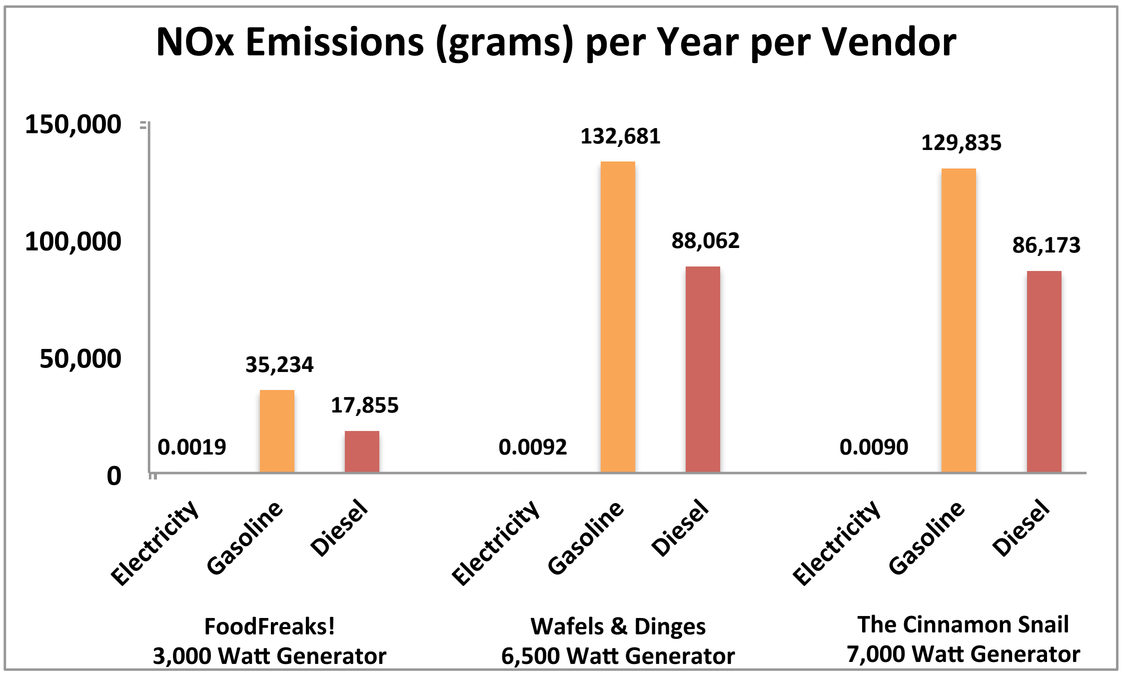

Figure 6: Projected annual emissions by source; Data from manufacturer specification sheets, collected from vendors, energy consumption calculations and The Inventory of New York City Greenhouse Gas Emissions

According to the EPA, a typical passenger car emits 38.2 lbs. (or 17.3 kg) of NO_x annually. Thus we calculate that a 6,500 or 7,000-watt generator consuming energy near the levels of Wafels & Dinges and The Cinnamon Snail emit approximately 7.5 cars worth of NO_x annually.

Given the distribution of generator sizes uncovered in the canvass sample, the projection of NO_x reduction to the universe of permitted mobile food vendors assumed to use a generator would yield the avoided emissions equivalent to taking between 9,500 and 11,100 cars off the road for a year.

Discussion

Food for Thought:

Considering most vendors operate food carts with small generators, the City should have enough existing electrical capacity to provide grid power to most of these vendors. Therefore, designing an electrification pilot project for just food carts would be the simplest path forward, but would not be comprehensive. Trucks' needs may be harder to meet, but for precisely that reason they offer the most potential. They are the biggest energy users, and switching them to grid power would have the biggest benefits on a per-unit basis.

The calculations suggest that the trucks studied with 6,500- and 7,000-watt generators may be capable of operating below the 40 amp cut-off criteria. Tis report illustrates that both energy consumption and generator size should determine if a vendor makes the cut-off. Power use surges that can occur when equipment is turned on could be tested in a pilot by measuring actual, real-time power needs using an industrial grade energy measurement and data logging device. If the City decides to pursue a pilot, it would afford a testing period to determine how well trucks with different generator sizes and energy needs operate on grid power to evaluate the options for including trucks should such an initiative be scaled-up.

A pilot should require zero modification for vendors, just a 3-phase extension cord. It should also be made clear that electricity access is a benefit and not a right. Vendors that benefit from grid power in the future should always be ready to use their generators in case an outlet is unavailable.

The key challenges to execute a pilot or scale a program will be operational and economic. Operational challenges are beyond the scope of this study. The potential economic challenges we mention refer to the cost to set up and execute the pilot. The City is investigating these costs.

Suggestions for Further Study:

Spending the past several months paying close attention to food carts and trucks whether through study data, vendor social media feeds, or through observation, a number of issues stood out that the City should contemplate when considering next steps.

The most critical next step is to map out the operational and logistical challenges, as well as costs of planning and executing a pilot program. Special attention should be given to safety and simplicity. Safety relates to multiple aspects of executing a pilot such as how pedestrians will interact with infrastructure and power cords. Simplicity of pilot design and execution is key to achieving a successful outcome. To ensure economic viability, design should ensure a high utilization rate of any hardware that would need to be installed.

Logistics will require in-depth research, analysis and planning. While carts typically remain in one location during the day, trucks move throughout the day. Trucks also tend to vend from different neighborhoods throughout the week. Grid access points would have to be located in areas with heavy foot traffic for both lunch and dinner. While carts may find such access highly attractive given their stationary nature, trucks may opt to participate part-time. If grid access is placed strategically in busy areas, then perhaps a number of trucks could share these access points on designated days. Furthermore, contention over food truck parking would have to be factored into any pilot study involving trucks. In addition to the challenges vendors described and Tweeted about in finding a large enough parking space, they also vie with one another for prime vending spots.

Tim Rich, a researcher at Columbia University, conducted a study concurrent with ours that examined the movement of food trucks. Food trucks are much more nomadic than carts, moving from one to several times per day. Mr. Rich mapped the movement of a dozen trucks by mining data from their Twitter feeds. One of his maps is in **Appendix B**. Expanding the study of food truck movement and including feedback and context from the vendors themselves could uncover helpful information derived from patterns in food truck locations. The understandings gained from researching the conditions that dictate movement and the temporary site selection process of food trucks could provide New York City with actionable metrics to inform its pilot and better assess this increasingly popular segment of mobile vendors.

Locating grid access points in prime vending locations makes sense because the vendors are already there. A true test of any such pilot will be how grid access is granted. Will an equitable process be instituted? How much input will be solicited from vendors? Vendors who are granted access may be perceived by the public as “greener” than others, potentially giving them an advantage in image and marketing. The process should be designed to be as fair and transparent as possible.

Tracking vendor power use in terms of duration, quantity consumed and location will be an essential component not only for billing vendors, but also for analyzing the interplay between power supply and demand.

Our final suggestion is for the City to pursue a cost effective way to support the operational feasibility study. This could be achieved by approaching relevant graduate programs (i.e. civil or electrical engineering) at local universities to offer this as a capstone project. Most graduate programs require some form of semester-long, challenging team project for degree completion. New York offers a rich pool of talent that could provide such pro-bono service to the City.

Conclusion:

The combination of in-depth analysis of energy usage along with results from a high-level, broader canvass indicates the potential size for electrification is substantial. The analysis of energy use and emissions demonstrate that per-unit pollution reductions would be significant. Reducing local emissions in particular embodies the spirit of PlaNYC. For vendors, the costs of gasoline are high and variable. Providing grid power would establish more stable and attractive energy pricing for the vendors.

Electrification of food cars and trucks is an exciting opportunity for the City to engage small businesses and offer them a way to operate in a more cost-effective and environmentally responsible manner.

Acknowledgements

Many people graciously volunteered their time and expertise to make this study a reality. We thank you.

Food vendors: Thomas DeGeest, Steve Lipschutz and the truck staff at Wafels & Dinges; Alex at Kelvin Slush; John at FoodFreaks!; and Adam Sobel, Shawn and the rest of the crew at The Cinnamon Snail.

Consultants: Ryan Meinke, independent senior sustainability consultant, for projecting CO_2 for the vendor universe; Tim Rich, M.A. for sharing his map of food truck movement based on Twitter feeds.

Truck Expertise: Jay Celona, the Director of Engineering and Design from Custom Sales and Service Inc.

Interns: Lauren Singer for creating the maps on page 11 and for helping design and test the canvassing approach; and the canvassers Jonathan Aisenberg, Jack Oliphant, Taylor Palmer, Tatiana Hyman, Rachel Adams.

Electrical engineers: Jochen Spengler and Reza Yazdani

Sources

Emissions:

PlaNYC, Inventory of New York City Greenhouse Gas Emissions (Sept 2011)
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Environmental Protection Agency
http://www.epa.gov/cleanenergy/energy-resources/refs.html
http://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100CZFN.PDF
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http://www.nyserda.ny.gov/Page-Sections/Energy-Prices-Supplies-and-Weather-Data/Motor-Gasoline/
NYSERDA, Diesel Prices
http://www.nyserda.ny.gov/Page-Sections/Energy-Prices-Supplies-and-Weather-Data/On-Highway-Diesel/

Generator Specifications:

Honda
http://powerequipment.honda.com/generators/compare/?modelid=EU2000IKN&modelid=EU3000ISAN&
Cummins
http://www.cumminsonan.com/www/html/Common/pdf/specsheets/a-1443.pdf

Regulations:

Environmental Protection Agency, Regulations for Nonroad Diesel Engines (kW < 8, hp < 11)
http://www.dieselnet.com/standards/us/nonroad.php
Environmental Protection Agency, Regulations for Nonroad Engines (kW < 19, hp < 25) (Class I <225cc, Class
http://www.epa.gov/ttn/atw/area/fr18ja08.pdf
http://www.gpo.gov/fdsys/pkg/FR-2008-10-08/pdf/E8-21093.pdf
http://www.epa.gov/otaq/equip-ld.htm

Other:

Electric Power Research Institute, Charging an iPad for a year
http://my.epri.com/portal/server.pt/gateway/PTARGS_0_243352_317_205_776_43/http%3B/uspalecp604%3B7087/publishedcontent/publish/epri_calculates_annual_cost_of_charging_an_ipad_at__1_36_da_855261.html
NYC Food Truck Movement – Twitter mapping
* Report being completed with expected 2012 submission to the Mayor's Office of the City of New York

Appendices

Appendix A:
Emission tables comparing the three generators per unit, month and year

Appendix B:
Map of food truck movement

Appendix A: Comparison of the three generators studied with estimated per-unit, monthly and annual emissions

Food Freaks - 3,000 watt generator
Wafels & Dinges - 6,500 watt generator
Cinnamon Snail - 7,000 watt generator

	CO_2 Emissions (Lbs.) per Vendor, Grid vs. Gasoline			
Source	**unit**	**CO_2 per unit**	**Monthly**	**Yearly**
Electricity	kWh	0.66	130.29	1,564
Gasoline	Gallon	19.67	657.97	7,896
Diesel	Gallon	22.44	750.91	9,011
Electricity	kWh	0.66	642.62	7,711
Gasoline	Gallon	19.67	3,349.64	40,196
Diesel	Gallon	22.44	3,822.80	45,874
Electricity	kWh	0.66	628.83	7,546
Gasoline	Gallon	19.67	3,281.64	39,380
Diesel	Gallon	22.44	3,745.19	44,942

Table 4: Projected CO_2 emission figures by vendor source; Data from manufacturer specification sheets, collected from vendors, calculations and The Inventory of New York City Greenhouse Gas Emissions

Food Freaks - 3,000 watt generator
Wafels & Dinges - 6,500 watt generator
Cinnamon Snail - 7,000 watt generator

	NO_x Emissions (grams) per Vendor, Grid vs. Gasoline			
Source	**unit**	**NO_x per unit**	**Monthly**	**Yearly**
Electricity	kWh	0.00000078	0.00015	0.0019
Gasoline	Gallon	14.80	2,936.15	35,234
Diesel	Gallon	7.50	1,487.91	17,855
Electricity	kWh	0.00000078	0.00076	0.0092
Gasoline	Gallon	11.30	11,056.72	132,681
Diesel	Gallon	7.50	7,338.53	88,062
Electricity	kWh	0.00000078	0.00075	0.0090
Gasoline	Gallon	11.30	10,819.55	129,835
Diesel	Gallon	7.50	7,181.11	86,173

Table 5: Projected NO_x emission figures by vendor source; Data from manufacturer specification sheets, collected from vendors, calculations and The Inventory of New York City Greenhouse Gas Emissions

Appendix B: Food trucks can have heavy migration patterns, requiring more access points or more limited participation than carts. **Figure 7** shows the movement of 12 trucks based on two weeks of each vendors' Twitter feeds.

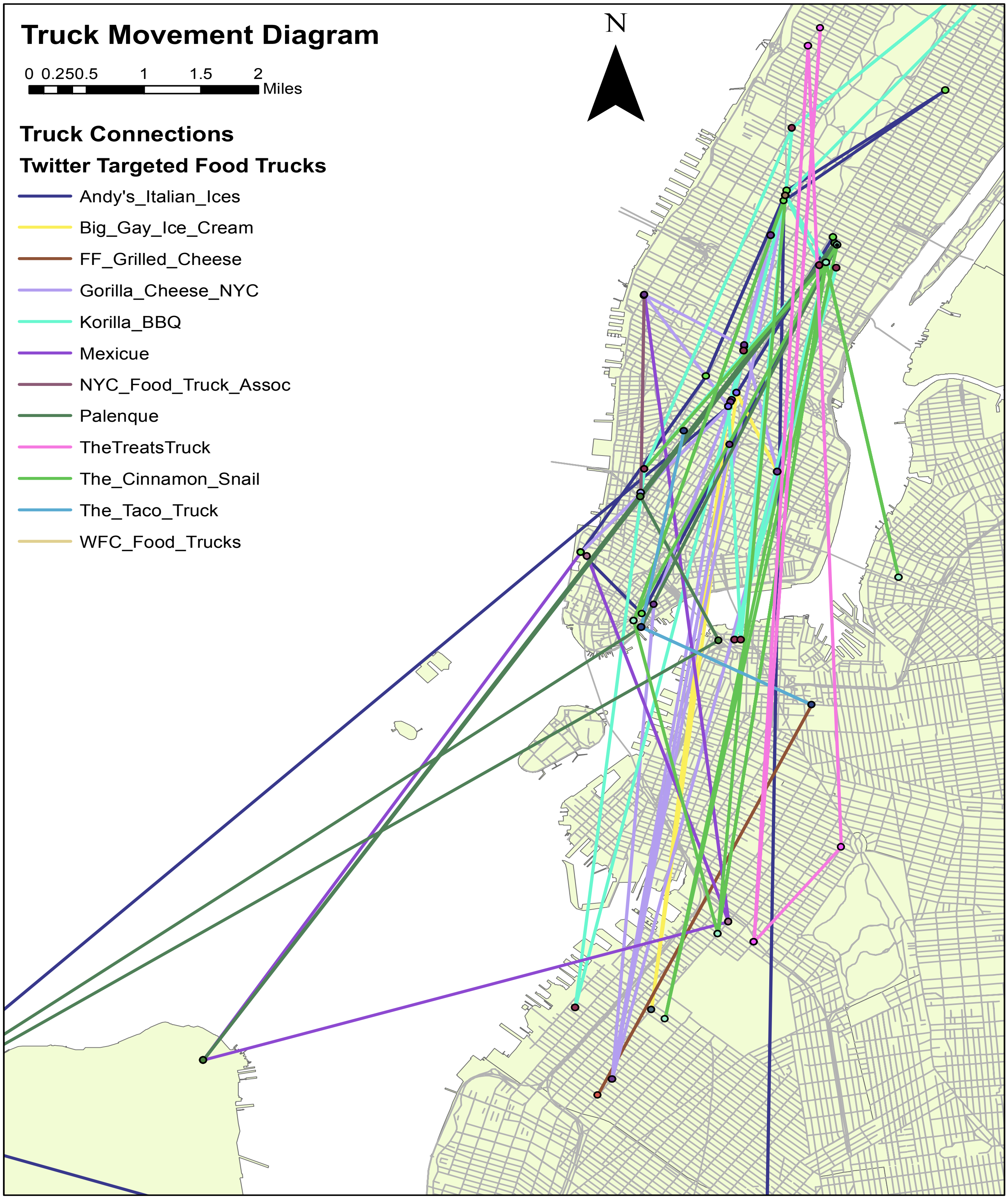
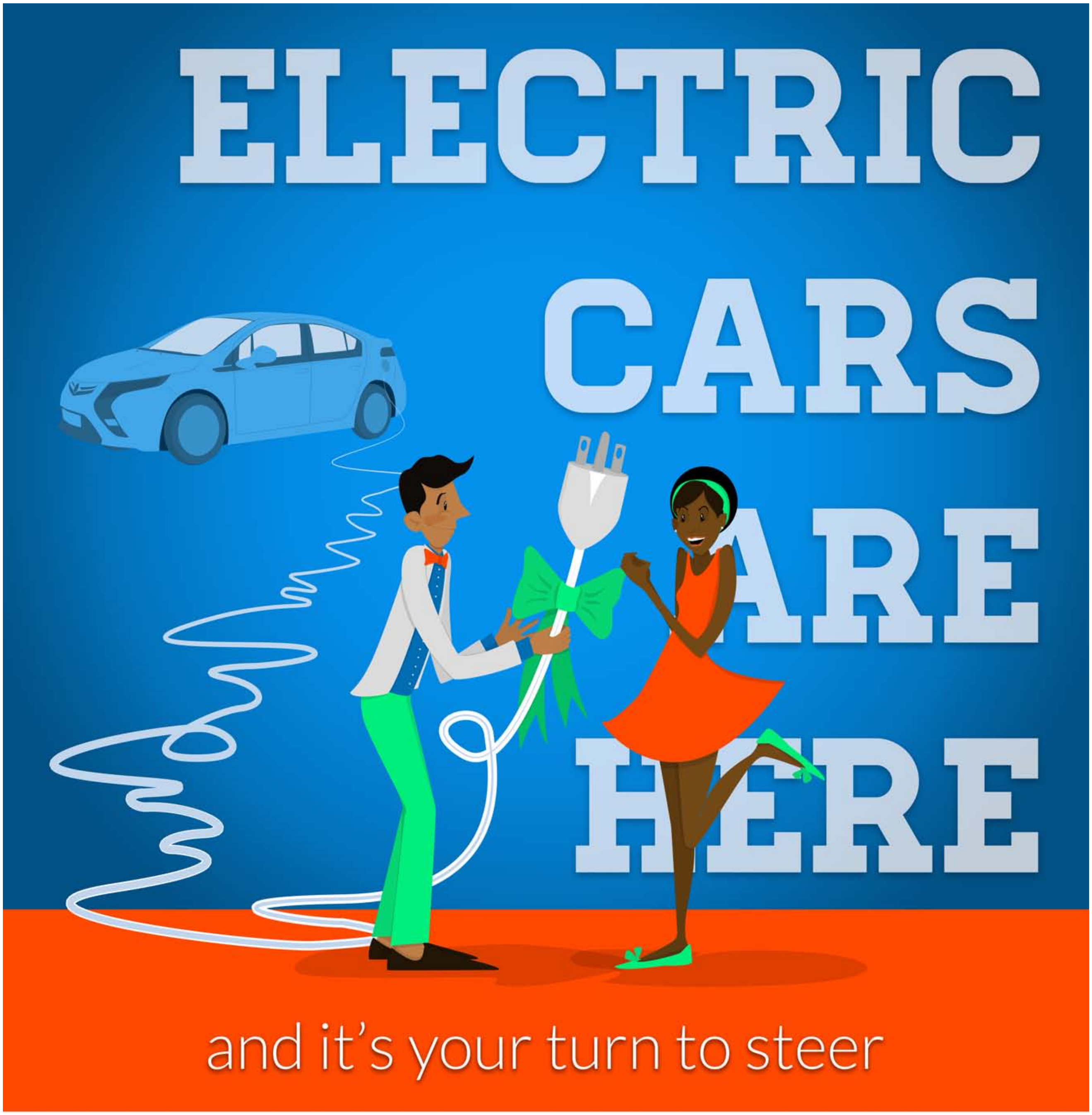


Figure 7
Source: Tim Rich M.A., Map generated from vendors' Twitter feeds

Appendix C **Mission Electric Resources**

Appendix C-1 Proof of Mission Electric Bus Shelter Advertisement



vote at **MISSIONELECTRIC.ORG**

MISSION ELECTRIC
NEW YORK CITY

Clean Cities

planYC

Appendix C-2 Select Articles from Duane Reade Campaign

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TriplePundit people, planet, profit

popular now: ** abu dhabi blogging contest ** | the future of biofuel | refrigerant revolution | gre

Duane Reade Asks New Yorkers to Decide Which Stores Will Switch to Electric Trucks

By Raz Godelnik | August 27th, 2012 0 Comments

Like 7 +1 2 Tweet 21 Share 13

Businesses are warming up to the idea of crowdsourcing more and more to help them become more sustainable. Unilever asked for ideas about sustainable showering, Heineken looked for some help in designing a greener six pack, and now Duane Reade is asking the public to help it decide which of its stores in New York City will switch to electric trucks. It's true that participants don't need to contribute their creativity to the decision-making process, in this case, but this time they're getting an opportunity to make an impact not only on the company, but also on their own neighborhood.

This initiative is a result of collaboration between Mission Electric, a partnership among non-profits and the mayor's offices of Boston, Philadelphia, and New York City to educate and engage the public around electric vehicles and Duane Reade, which is looking to switch 25 percent of its fleet to electric trucks over the next year. The company has already selected five stores in New York City to serve with e-trucks, and now is asking the public to vote (on Mission Electric's website) which two additional stores in the Big Apple will be going completely electric.

It all started with the vision of electric cars as part of a cleaner future, which Mission Electric works to promote among the residents of New York. "While we are fans of electric vehicles, our goal is not to sell cars, but to give the public a right to choose and participate in the future of urban transportation. If we can get this right with cars, imagine what else we as citizens can do," Asaf Selinger, project manager at Mission Electric told me.

"In our partnership with Duane Reade we are getting New Yorkers to rethink the way their goods get transported to the store. We all complain about pollution and noise, and here we're actually giving residents a solution that they can decide on. Every year each of these electric trucks will save 16,000 gallons of diesel, that's 224,000 gallons," he added.

And what about Duane Reade? To learn more about their perspective on the campaign, I got in touch with Michael Fowles, Fleet Manager at Duane Reade.

TriplePundit: What benefits do you hope to gain from purchasing 14 electric trucks?

Michael Fowels: In addition to being employees of Duane Reade/Walgreens, we are also residents of NYC. As such, we want to contribute to the livability of the New York Metropolitan area by reducing our carbon footprint, noise, congestion, and pollution that result from a traditional delivery. Our electric trucks are noise free, emission free, and allow us to deliver opportunistically to reduce congestion.

3p: What feedback do you get from your truck drivers? Do they like the shift to electric cars?

MF: Our drivers were initially skeptical about the electric trucks, but virtually all have now embraced them and many prefer to drive the electric trucks over their diesel counterparts. The drivers indicate they are more alert when driving and more relaxed at the end of the shift due to less truck vibration and virtually no noise, in comparison to the diesel vehicles in our fleet.

3p: Do you have plans to replace the rest of your fleet to electric cars in the near future?

MF: We are interested in continuing to explore expanding our fleet as we address current limitations of the electric trucks such as time required to charge, driving range between charges and cost.

3p: What about your customers – do you receive any feedback from them? Do you think they care about it?

MF: Our customers who understand or take the time to learn about our environmental initiatives are usually always impressed and complimentary. Our drivers have commented on unsolicited positive feedback they've received from complete strangers about the electric trucks. I really like to observe the reaction of people when they can see what the truck can do without an internal combustion engine – it's pretty amazing!

3p: How do you promote the campaign online and in the stores?

Smith Electric and Duane Reade Expand Electric Delivery Fleet

By Nick Kurczewski · July 23, 2012

Duane Reade will have 14 Smith Electric EVs in its fleet by the end of the month. (Nick Kurczewski photo)

New Yorkers are never shy when it comes to voicing their opinion, which might explain why Duane Reade, one of the city's most popular pharmacies, and Smith Electric Vehicles have teamed to ask city residents to vote for which of two stores they'd like served by a fully electric delivery truck. Customers can vote online, using a map provided by Mission Electric a non-profit specializing in bringing attention to electric vehicles in New York, Boston, and Philadelphia. "[The site] is a portal for New Yorkers to communicate about electric vehicles," said Asaf Selinger, project manager for Mission Electric. "It allows customers to take control of EV policy." By month's end, 25 percent of Duane Reade's New York delivery fleet (14 trucks in total) will be electric-powered Smith Electric vehicles. The trucks are recharged nightly at Duane Reade's distribution center in Maspeth, Queens.

Not Your Average EV

The Smith Electric trucks themselves might not be what most New Yorkers, or anyone else for that matter, associates with a zero-emission vehicle. For starters, they're very big. At 24 feet in length, and with a 26,000 gross vehicle weight (GVW), these are currently the largest trucks built by Smith Electric. The example parked curbside during the press conference, held in Manhattan's Upper East Side, certainly attracted attention, thanks in large part to the "Breathe Easy" and "100% Electric, 100% Emission Free" logos emblazoned on either side. Smith Electric, which is based in Kansas City, Missouri, plans on building trucks destined for a working life in New York City at a new plant in the South Bronx. That plant was announced with fanfare, and generous subsidies from both state and city government. Frito-Lay and Coca-Cola are also among the company's clients in the New York City market.

Energizing the Public, Charging the Trucks

Raising public awareness about electric vehicles, and establishing the city infrastructure to support them, is crucial, explained David Bragdon, New York City's director of long term planning and sustainability. Other than promotional efforts—such as Duane Reade's invitation to allow customers to pick retail locations best served by a Smith Electric EV—Bragdon said it was up to the city to make it "easier to charge" the trucks. That includes "finding subsidies for charging installations," along with "building public awareness" about the vehicles.

Induction (i.e. wireless) charging and fuel cell vehicles are also planned for Smith Electric's New York fleet. Prototypes are expected to be running within the next six to 12 months, though no specifics were available regarding when either technology might be put into routine service. Duane Reade is exploring inductive charging in a project with Plugless Power.

Duane Reade Moves To Electrify Some of its Fleet

By Jim O'Grady | 07/17/2012 – 3:39 pm

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(photo by Edgar Zuniga Jr. via flickr)

(New York, NY – **WNYC**) **Duane Reade**, the largest drug store chain in New York City, says it will electrify a quarter of its truck fleet .

The company claims converting 14 of its 60 trucks to electricity will reduce its greenhouse gas emissions by about 20 percent.

(Which they say is, in technical parlance, "the nitrous oxide equivalent of 1,000 tailpipes removed.")

Environmental group **Mission Electric** is working with Duane Reade to let the public vote on the first seven stores to get the green trucks. The company will be rolling out the voting Wednesday at an event held in conjunction with Mayor Bloomberg's Office of Long-Term Planning and Sustainability. Office director David Bragdon said "Duane Reade's investment in electric vehicles will help meet our ambitious **PlaNYC** goal of reducing NYC's green house gas emissions."

Duane Reade says the move will reduce air pollution, noise, and congestion. One added benefit — especially welcome to sleep-deprived New Yorkers: "Because the new trucks do not require combustion, their operation is almost silent, reducing noise levels from overnight deliveries."

Appendix C-3 Screen Shot of NYC.gov/driveelectric

Appendix C-4 Mission Electric Initial Visioning

Original visioning for Mission Electric. Utilized examples of interactive and engaging public crowd sourcing sites.

EV VISIONING

INNOVATIVE PUBLIC ENGAGEMENT ON ELECTRIC VEHICLES IN PHILADELPHIA, BOSTON, AND NEW YORK CITY

Clean Cities | NYC | BOS | PHL | PURPOSE | | OpenPlans

February 10, 2012

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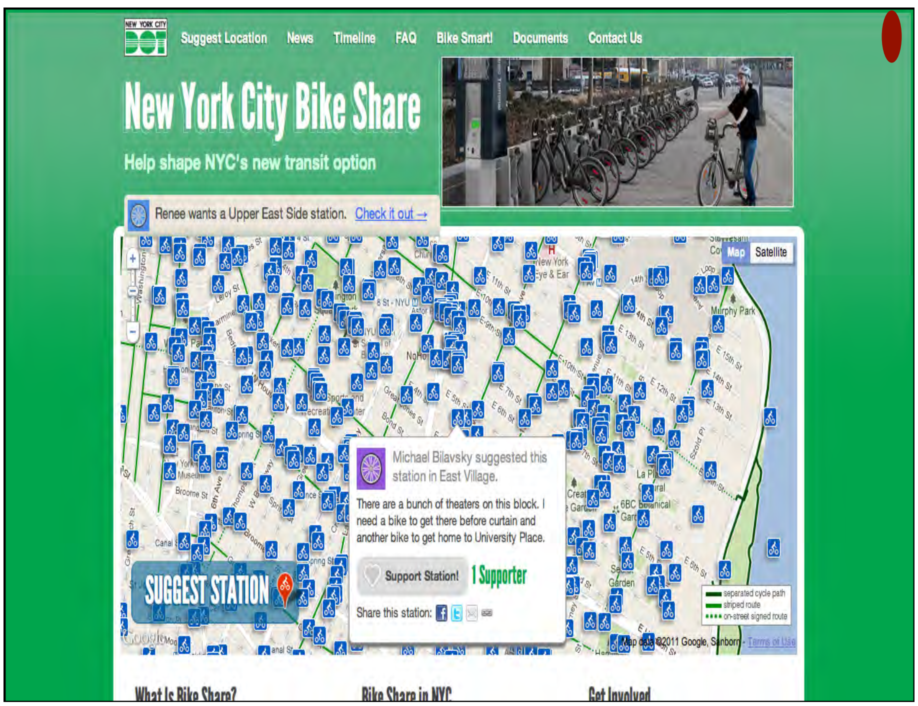
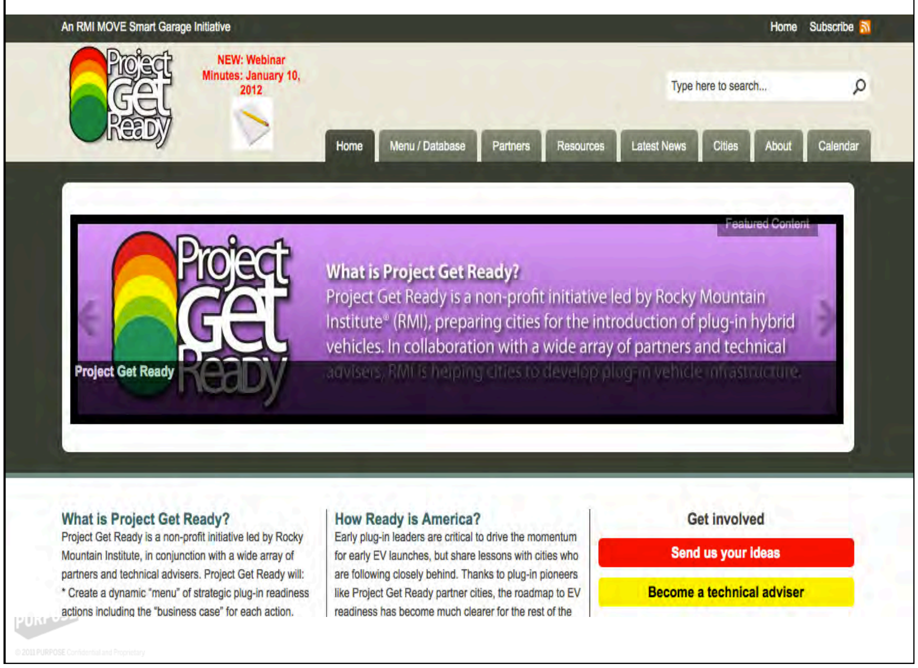
5:25-5:30	Wrap up

Goals for today

- Team building
- Project briefing
- Discuss strategic and logistical questions
- Identify 3 top campaign concepts



What are other EV Readiness initiatives doing?



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What We're Doing
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Get Ready Central Florida (GRCF) is a coalition of state and local governments, utility providers, businesses, and electric vehicle enthusiasts committed to preparing Central Florida for the early release of highway-ready, plug-in electric vehicles. Through research, education, and implementation,
Get

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Virginia EV
Helping bring Electric Vehicles to Virginia
VCC Home
Electric Vehicles
Clean Diesel
Green Operators
Propane
Home
VA EV User Photos
VA Local EVSE Permitting Contacts
Virginia EV Businesses
What is an Electric Vehicle
EV Technology and Infrastructure Course
J. Sargeant Reynolds Community College is now offering a trial course this quarter on Electric Vehicles and Infrastructure. This one credit course will teach you the advantages and differences between electric and traditional vehicles. Registration information can be found here. Electric Vehicle Flyer_1 For more information or to register, contact Katherine Falconer at kfalconer@reynolds.edu or ...
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DOE Alt Fuel Glossary
DOE Electric Vehicle Info
Free Chargers in Northern Virginia Through Chargepoint America
Project Get Ready Resources
Public Charger (EVSE) Map


EV ROADMAP.com
THE WAY TO GO
TARGET 2010
Oregon "ramps up and amps up" EV charging stations
The state of Oregon is partnering with Portland General Electric, eTec and Nissan North America to deploy up to 4,700 zero-emission electric vehicles, the Nissan, LEAF, and 11,210 charging systems to support them in strategic markets in five states. > MORE
> EV Road Map
> Oregon EV Companies
> Charging Infrastructure
> Plans & Projects
> Partners
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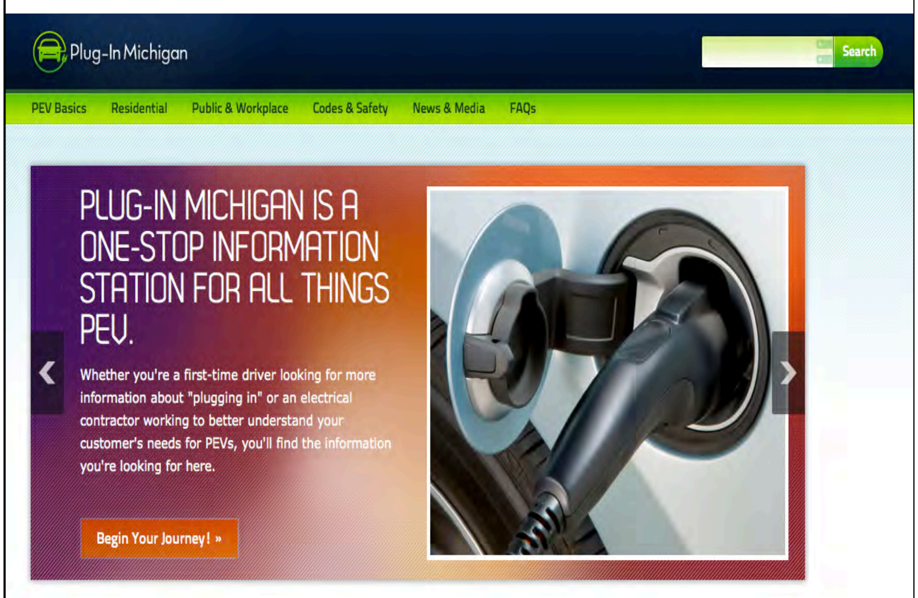
> About Us
THE WAY TO GO IN OREGON
Plug-In Prius Project Begins in Oregon
Ten 2010 Toyota Plug-in Priuses will be motoring around Portland, Salem, Corvallis, and Eugene for the next year or so starting in August as part of a worldwide Toyota Demonstration Project
> PRESS RELEASE > NEWS COVERAGE > TOYOTA
Ford Kicks Off PSU Tour
Portland State University's Urban Center hosted the start of the Ford Motor Company's 14 city "Charging Into the Future Tour" to show off their upcoming lineup of electric, hybrid electric and plug-in hybrid electric vehicles that will be arriving in 2011, 2012 and beyond.
Ford is teaming up with Portland General Electric in
As seen on:
GreenLivingPDX


Plug-In Michigan
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Public & Workplace
Codes & Safety
News & Media
FAQs
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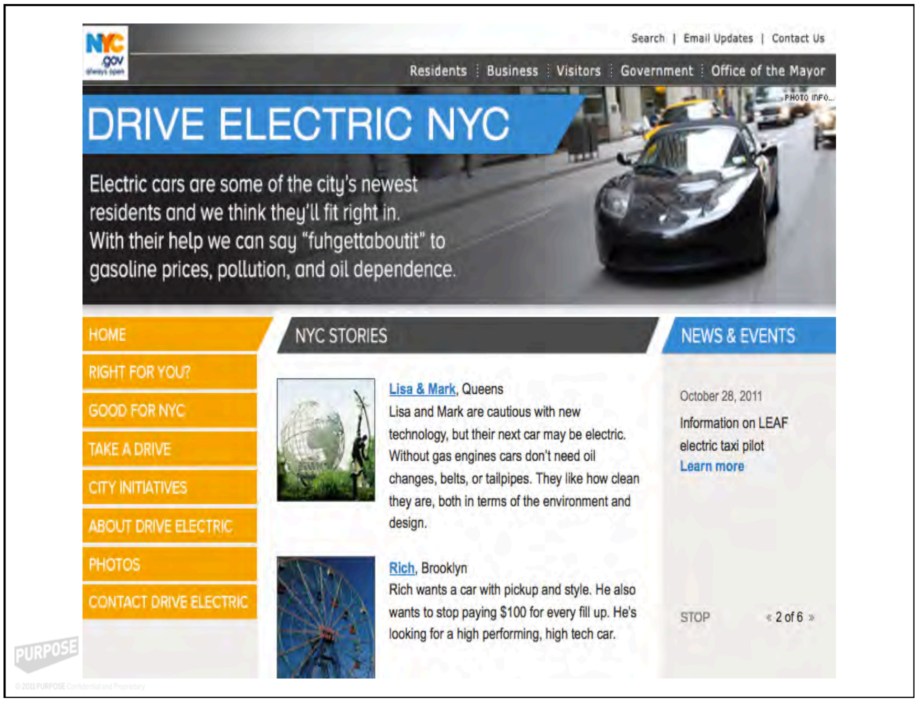
Whether you're a first-time driver looking for more information about "plugging in" or an electrical contractor working to better understand your customer's needs for PEVs, you'll find the information you're looking for here.
Begin Your Journey! »



What are the most innovative EV projects that engage consumers?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Use the app and the BMW EV Dashboard to analyze your driving habits and determine if a BMW ActiveE or an upcoming BMW electric vehicle will be right for you.
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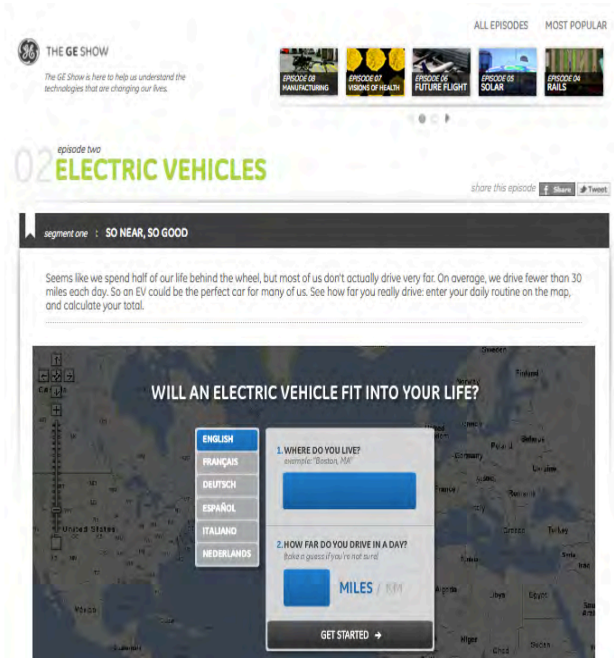
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The GE Show is here to help us understand the technologies that are changing our lives.
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EPISODE 07 VISIONS OF HEALTH
EPISODE 06 FUTURE FLIGHT
EPISODE 05 SOLAR
EPISODE 04 RAILS
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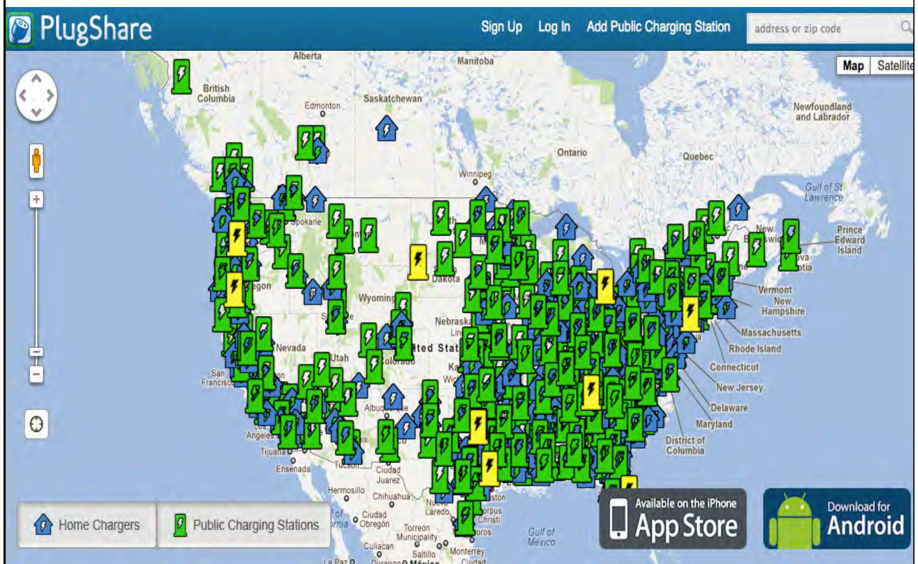
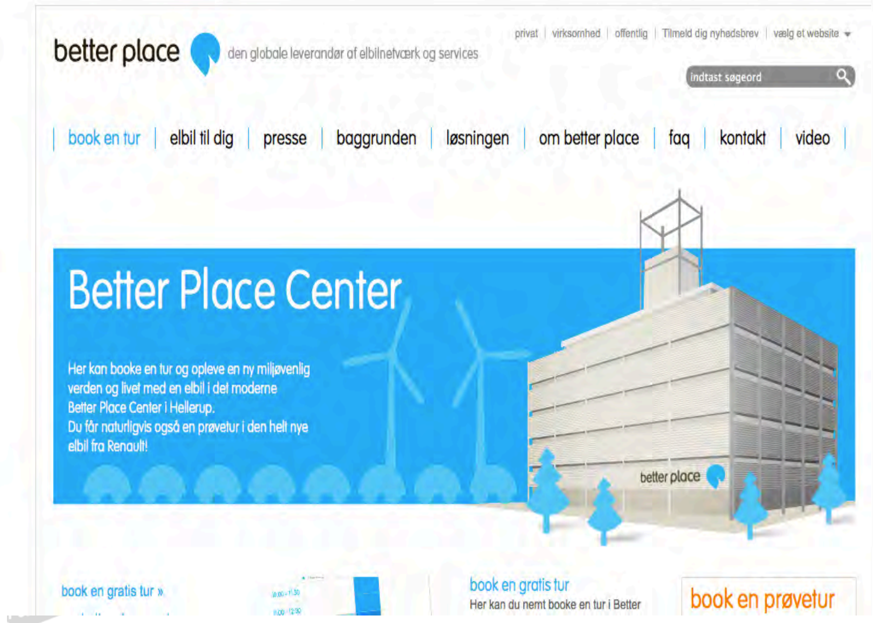
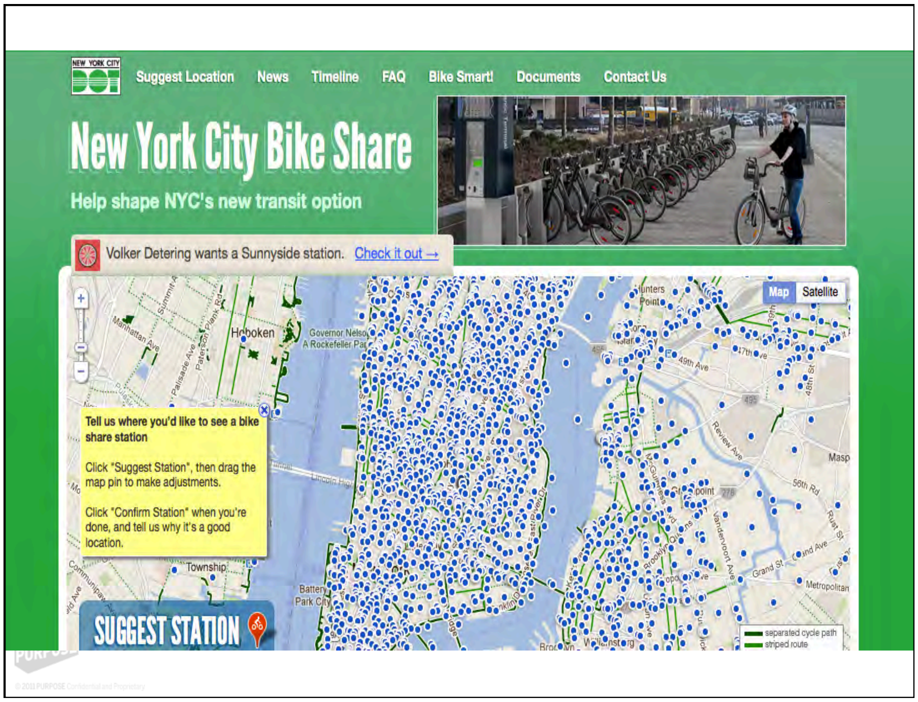
Tweet
segment one : SO NEAR, SO GOOD
Seems like we spend half of our life behind the wheel, but most of us don't actually drive very far. On average, we drive fewer than 30 miles each day. So an EV could be the perfect car for many of us. See how far you really drive: enter your daily routine on the map, and calculate your total.
WILL AN ELECTRIC VEHICLE FIT INTO YOUR LIFE?
ENGLISH
FRANÇAIS
DEUTSCH
ESPAÑOL
ITALIANO
NEDERLANDS
1. WHERE DO YOU LIVE?
example: "Boston, MA"
2. HOW FAR DO YOU DRIVE IN A DAY?
Take a guess if you're not sure
MILES / KM
GET STARTED


PlugShare
Sign Up
Log In
Add Public Charging Station
address or zip code
Map
Satellite
Home Chargers
Public Charging Stations
Available on the iPhone
App Store
Download for
Android

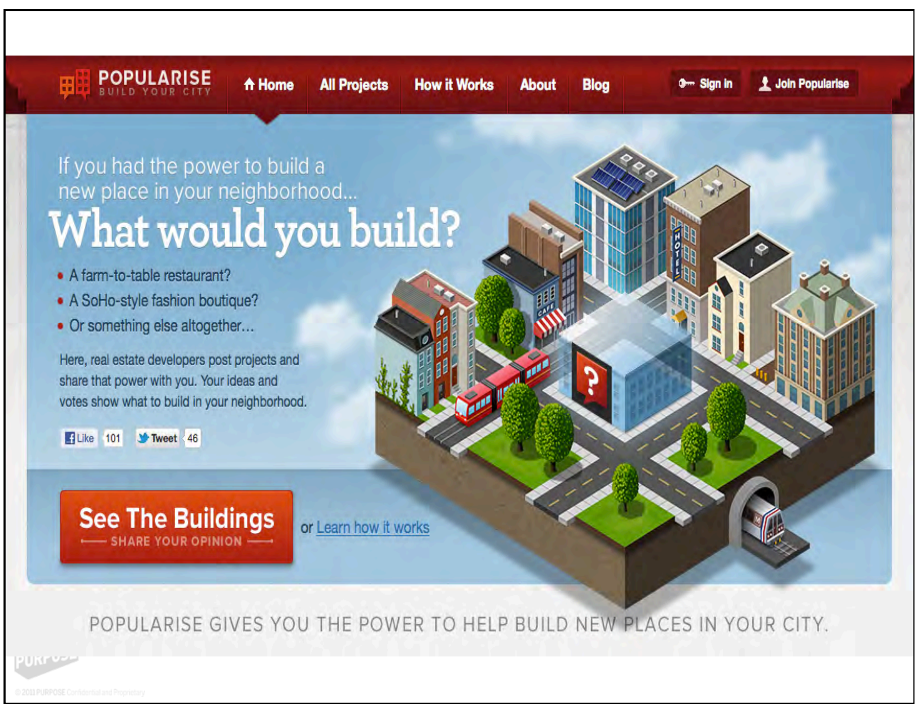

testenelbil.dk



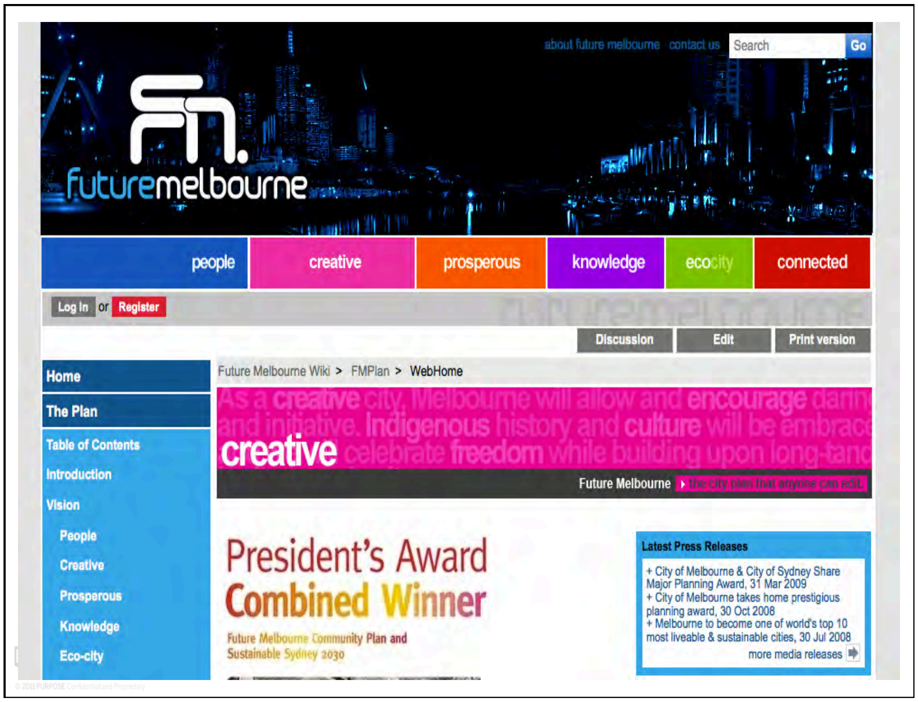
What are the most inspiring, relevant public engagement initiatives?

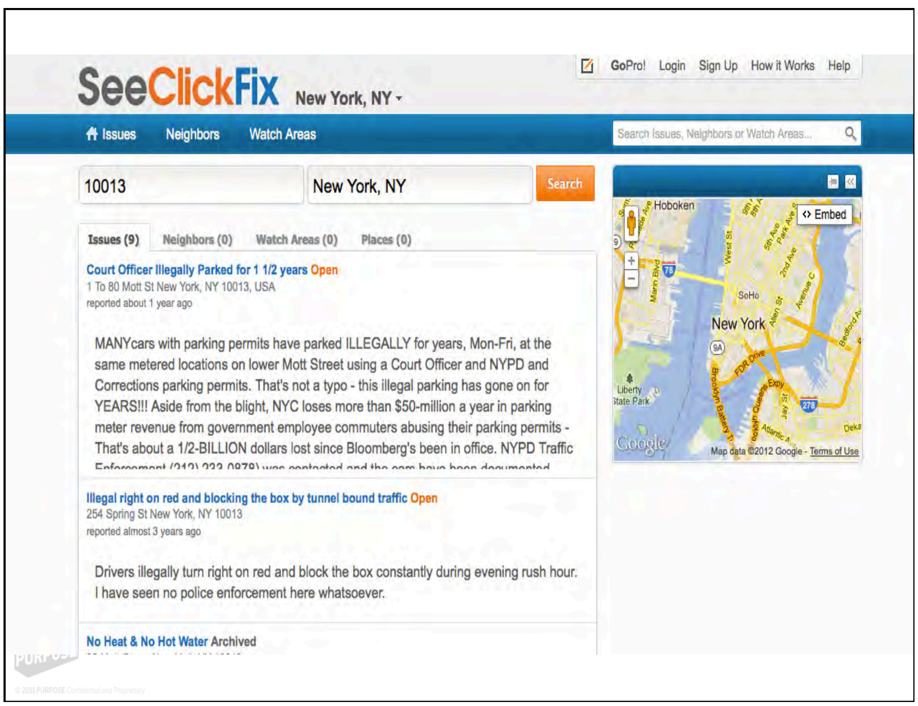


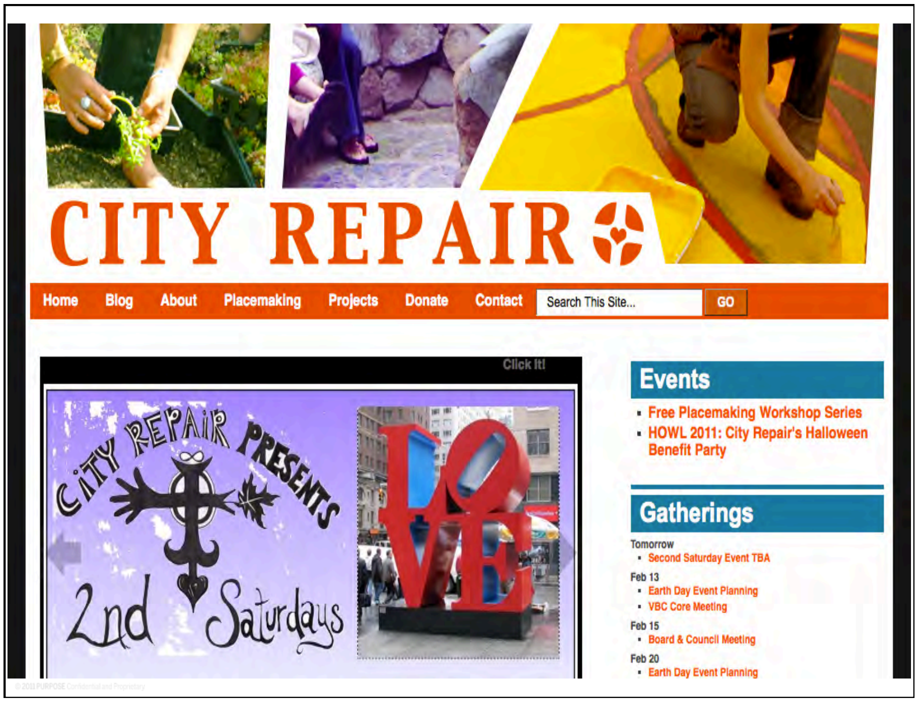
Suggest Location News Timeline FAQ Bike Smart! Documents Contact Us
New York City Bike Share
Help shape NYC's new transit option
Volker Detering wants a Sunnyside station. Check it out →
Tell us where you'd like to see a bike share station
Click "Suggest Station", then drag the map pin to make adjustments.
Click "Confirm Station" when you're done, and tell us why it's a good location.
SUGGEST STATION
Map Satellite
separated cycle path
striped route

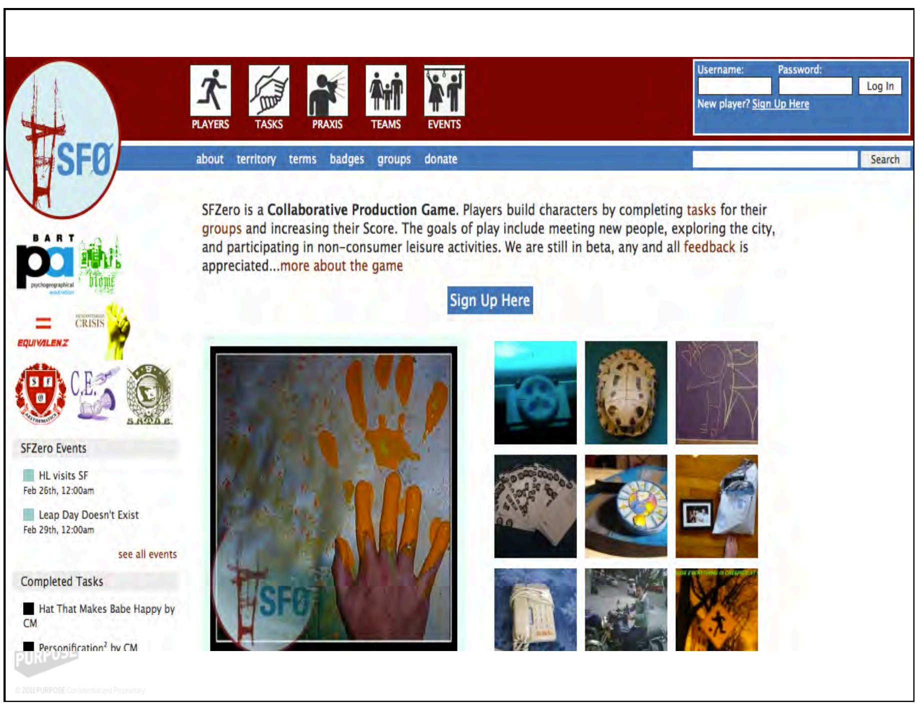


POPULARISE
BUILD YOUR CITY
Home All Projects How it Works About Blog
Sign in
Join Popularise
If you had the power to build a new place in your neighborhood...
What would you build?
A farm-to-table restaurant?
A SoHo-style fashion boutique?
Or something else altogether...
Here, real estate developers post projects and share that power with you. Your ideas and votes show what to build in your neighborhood.
Like 101 Tweet 46
See The Buildings
SHARE YOUR OPINION
or Learn how it works
POPULARISE GIVES YOU THE POWER TO HELP BUILD NEW PLACES IN YOUR CITY.


about future melbourne
contact us
Search
Go
futuremelbourne
people
creative
prosperous
knowledge
ecocity
connected
Log in
or
Register
Discussion
Edit
Print version
Home
The Plan
Table of Contents
Introduction
Vision
People
Creative
Prosperous
Knowledge
Eco-city
Future Melbourne Wiki > FMPlan > WebHome
As a creative city, Melbourne will allow and encourage daring and initiative. Indigenous history and culture will be embraced
creative
celebrate freedom while building upon long-tand
Future Melbourne
the city plan that anyone can edit
President's Award
Combined Winner
Future Melbourne Community Plan and Sustainable Sydney 2030
Latest Press Releases
+ City of Melbourne & City of Sydney Share Major Planning Award, 31 Mar 2009
+ City of Melbourne takes home prestigious planning award, 30 Oct 2008
+ Melbourne to become one of world's top 10 most liveable & sustainable cities, 30 Jul 2008
more media releases


SeeClickFix
New York, NY
GoPro!
Login
Sign Up
How it Works
Help
Issues
Neighbors
Watch Areas
Search Issues, Neighbors or Watch Areas...
10013
New York, NY
Search
Issues (9)
Neighbors (0)
Watch Areas (0)
Places (0)
Court Officer Illegally Parked for 1 1/2 years Open
1 To 80 Mott St New York, NY 10013, USA
reported about 1 year ago
MANYcars with parking permits have parked ILLEGALLY for years, Mon-Fri, at the same metered locations on lower Mott Street using a Court Officer and NYPD and Corrections parking permits. That's not a typo - this illegal parking has gone on for YEARS!!! Aside from the blight, NYC loses more than $50-million a year in parking meter revenue from government employee commuters abusing their parking permits - That's about a 1/2-BILLION dollars lost since Bloomberg's been in office. NYPD Traffic
Illegal right on red and blocking the box by tunnel bound traffic Open
254 Spring St New York, NY 10013
reported almost 3 years ago
Drivers illegally turn right on red and block the box constantly during evening rush hour. I have seen no police enforcement here whatsoever.
No Heat & No Hot Water Archived
Embed
Hoboken
SoHo
New York
Liberty State Park
Map data ©2012 Google - Terms of Use


CITY REPAIR
Home Blog About Placemaking Projects Donate Contact
Search This Site...
GO
Click It!
CITY REPAIR PRESENTS
2nd Saturdays
LOVE
Events
Free Placemaking Workshop Series
HOWL 2011: City Repair's Halloween Benefit Party
Gatherings
Tomorrow
Second Saturday Event TBA
Feb 13
Earth Day Event Planning
VBC Core Meeting
Feb 15
Board & Council Meeting
Feb 20
Earth Day Event Planning


PLAYERS TASKS PRAXIS TEAMS EVENTS
Username: Password:
Log In
New player? Sign Up Here
SFØ
about territory terms badges groups donate
Search
SFZero is a Collaborative Production Game. Players build characters by completing tasks for their groups and increasing their Score. The goals of play include meeting new people, exploring the city, and participating in non-consumer leisure activities. We are still in beta, any and all feedback is appreciated...more about the game
Sign Up Here
SFZero Events
HL visits SF
Feb 26th, 12:00am
Leap Day Doesn't Exist
Feb 29th, 12:00am
see all events
Completed Tasks
Hat That Makes Babe Happy by CM
Personification² by CM

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PURPOSE

Project Strategy

1. What are your guardrails and constraints for the tone and transparency of this campaign?
2. What are the goals of this project, beyond making the city more 'EV Ready'?
3. How would you measure the success of this project? More specifically, what are the performance measures for your department? How will this project's success be assessed by stakeholders in your city?
4. How does this project fit in relation other initiatives (e.g. Bike Share)? Are there opportunities to integrate efforts? How does this project fit the City's thinking on a more diverse portfolio of sustainable transportation options?

Project Logistics

1. What resources and capacity does each city bring to this project?
2. What is the relationship between the site and the three different cities?
3. What staff will be maintaining the project throughout its development? What will their roles be?
4. What are the options for "graceful exit scenarios" after the project duration has finished? Would a new entity be created to host this campaign & community, would an existing organization take on this responsibility, and/or other?
5. What are the potential staffing options for the future maintenance of this project? For example, who could manage social media communications?
6. Is there an opportunity / appetite to create a community of interested citizens, meaning that the project will have an email list for ongoing communication, surveys, and announcements?

Campaign Development

Campaign criteria: What does a successful campaign look like?

MUST HAVE	NICE TO HAVE
1. Educate people about Evs	1. Digitally interactive
2. Feedback that people have been heard	2. Social
3. Artifact of peoples' involvement	3. Build the list
4. Sustained engagement	4. Be in some way applicable to other cities/modular
5. Credible theory of change	5. Engage other industries
6. Cool factor	6. Enable consumer activism
7. Easily shareable with other people	7. Rewarding other EV supporters/users
	8. Catalyze investment

PURPOSE

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4

PURPOSE

First, let's get our existing ideas out on the table.

What if we had to partner with these stakeholders?

- Early buyers
- City fleet representatives
- EV clubs
- GM, Tesla and Nissan dealers
- Museums
- Car-sharing programs
- Policy-makers in other departments
- Food Truck operators
- Private fleet managers
- Local street artists

- Car rental services
- Straphangers
- Celebrities
- Race car drivers
- Taxi drivers
- Bikers
- Energy utilities

Thought starters

- What other decisions need to be made in the process of making our cities EV Ready, such as the location of EV charge spots? Use these decisions as starting points for ideation.
- What valuable resources do citizens have, like hyper-local knowledge and time? How can they used within the context of campaigns?
- How can campaigns increase opportunities for citizens to test-drive EVs?
- How can citizens have an 'EV experience' without physically experiencing the car?
- How can campaigns go where people already are, or embed themselves into what citizens already do?
- How can EV Readiness be integrated with a broader vision for sustainable mobility, involving public transit, bikes, and other sustainable transportation options? How to encourage efficient car usage vs. increased car usage?
- How can campaigns appeal to people who don't plan to buy a car, but are interested in sustainability?

Can we create campaigns that also overcome EV Readiness barriers?

- Not enough cars in the pipeline, OEMs need proof of future consumer demand
- How can we manage this as a multi-sector, city-wide project?
- How can we bring down upfront costs for consumers?
- Consumer hesitation at diving into a new paradigm for mobility
- Red tape around infrastructure installation
- What if these cars exacerbate my peak load?
- Who will pay for infrastructure?

Table of Contents

Concept Development

Elevator pitch:
What does this campaign do?

Timeline:
What is its timeline and duration? Can it connect to already-existing events?

Participation:
Who is most likely to participate and why?

Theory of change:
How do participants actions make their cities 'EV Ready'?

Goal:
How does this campaign fit with our campaign criteria?

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PURPOSE

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7

PURPOSE

Cheers!

Appendix C-5 Mission Electric Branding Rationale

Clean Cities
Name and Branding

PURPOSE | March 9, 2011

Meeting Agenda

Meeting Goals
Brand Architecture
Brand Attributes
Name Selection
Visual Branding

Meeting Agenda

1

Meeting Goals
Brand Architecture
Brand Attributes
Name Selection
Visual Branding

Meeting Goals

- Establish brand attributes
- Present name selection process and recommended name
- Review recommended visual branding

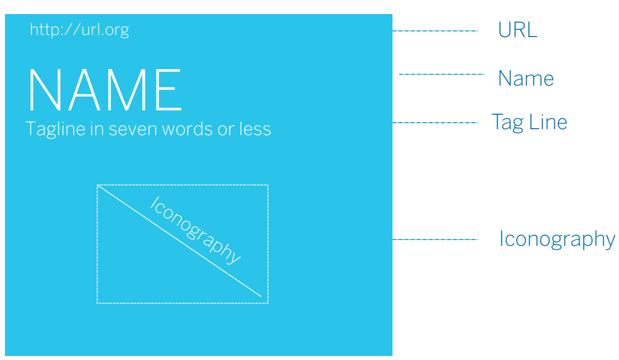
Meeting Agenda

2

- Meeting Goals
- Brand Architecture
- Brand Attributes
- Name Selection
- Visual Branding

BRAND ARCHITECTURE: The components of branding

Multiple components collectively communicate the brand



Meeting Agenda

3

- Meeting Goals
- Brand Architecture
- Brand Attributes
- Name Selection
- Visual Branding

Core Brand Attributes

Friendly / Approachable

Techie

Participatory

Local

Trustworthy / Credible

Cool

Thriving / Dynamic

Human

Brand DON'Ts

Irrelevant

Empty / static

Isolated / Disconnected

Clicktivism

Wonky

Sci-fi / Too futuristic

Meeting Agenda

4

Meeting Goals

Brand Architecture

Brand Attributes

Name Selection

Visual Branding

Name Stimuli

a) Core brand attributes (above)
b) Brand DON'Ts (above)
c) Value orientation
d) Word categories

Value orientation

The project has a **pragmatic orientation towards clean and efficient transportation**, versus an ideological orientation towards "greenness." When sustainability and the environment are referred to, it's within the context of previously established goals, e.g. the carbon emissions reduction goals of PlaNYC. **We're upgrading our transportation system with electric vehicles because it's the smart thing to do.**

Word categories (abbreviated)

Participatory	City	Action
We	Streets	Manifest
Us	Blocks	Actualize
Our	Intersection	Potential
Open	Green light	Capacity
Civic	Infrastructure	Capacitor
Citizen	Groundwork	Frontier
Community	Foundation	Dynamo
Social	Neighborhood	Mission
	Urban	Build
	City	Electrify
	Municipality	

Top 3 names

The City Electric

Street Potential

Mission Electric

Top 3 names

The City Electric – not contemporary enough

Street Potential

Mission Electric

Top 3 names

The City Electric – not contemporary enough

Street Potential – not straightforward, accessible enough

Mission Electric

Top 3 names

The City Electric – not contemporary enough

Street Potential – not straightforward, accessible enough

Mission Electric – the winner!

Meeting Agenda

5

- Meeting Goals
- Brand Architecture & Objectives
- Brand Attributes
- Name Selection
- Visual Branding

Our Recommendation

1

MISSION ELECTRIC

Alternative 1

2

MISSION ELECTRIC

Alternative 2

3

Mission Electric

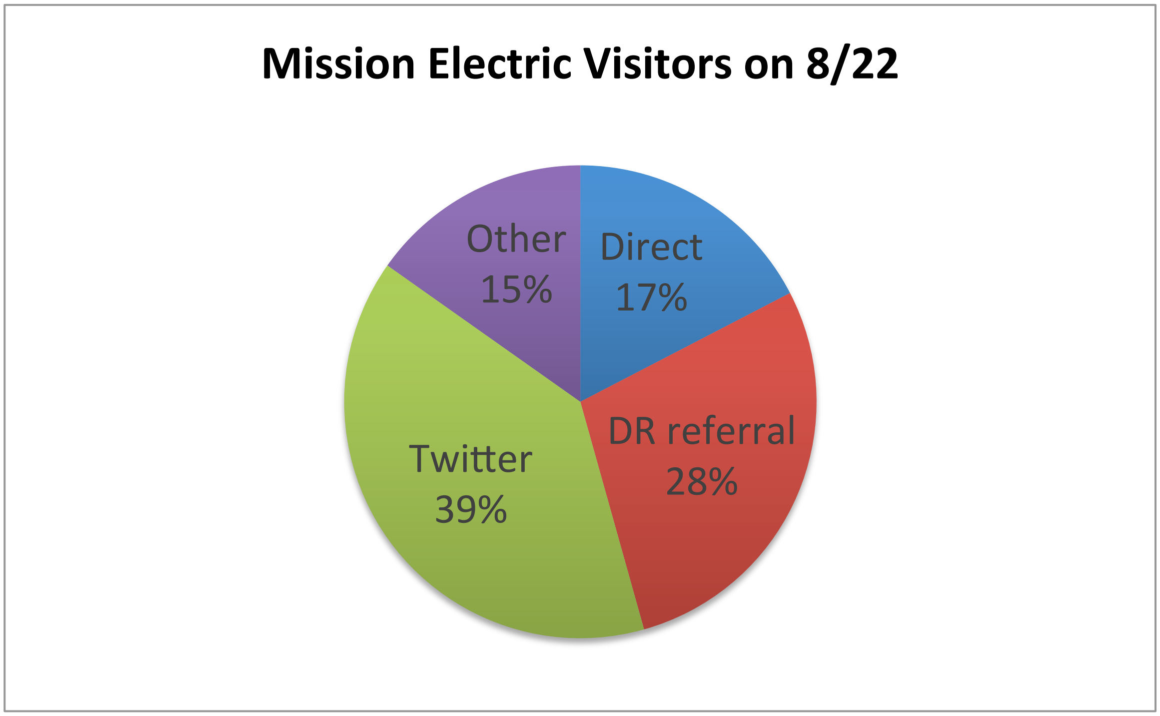
Alternative 3

4

Mission
Electric

Appendix C-6 Examples of Duane Reade in-store branding

Appendix C-7 Referral Sources for Mission Electric



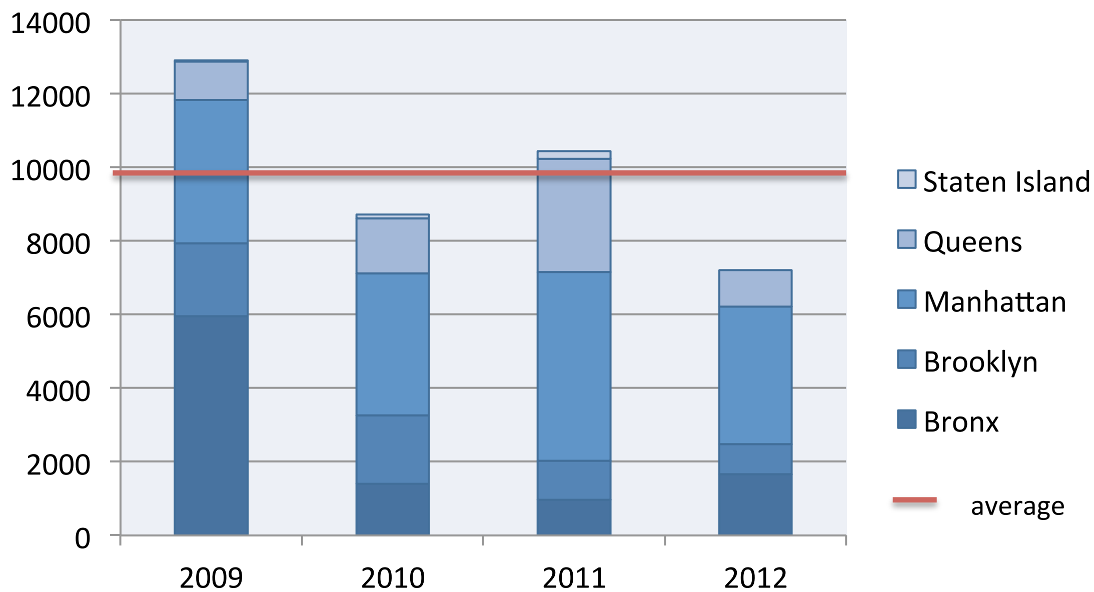
Appendix C-8 Record of Votes for Hertz Mission Electric Campaign

Location	Overall votes	Registered votes
Hertz Union Square	29	16
Hertz Upper West Side	23	12
Hertz Williamsburg	20	9
Hertz Long Island City	14	9
Hertz Midtown East	12	3
Hertz Upper East Side	11	5
Hertz Gramercy	11	4
Hertz Garment District	10	4
Total	**130**	**62**

Appendix D **New York City New Build Parking Attributes**

Appendix D-1 New Parking Spots Permitted in New York City

(1/2009-7/2012)



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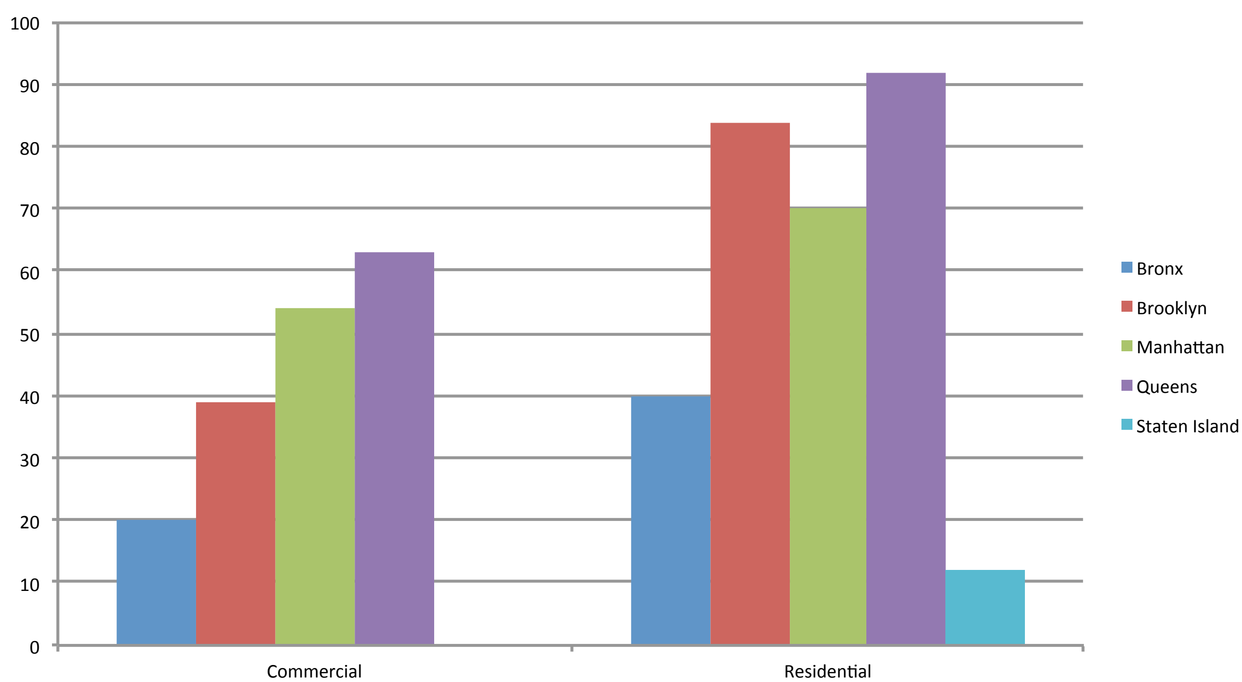
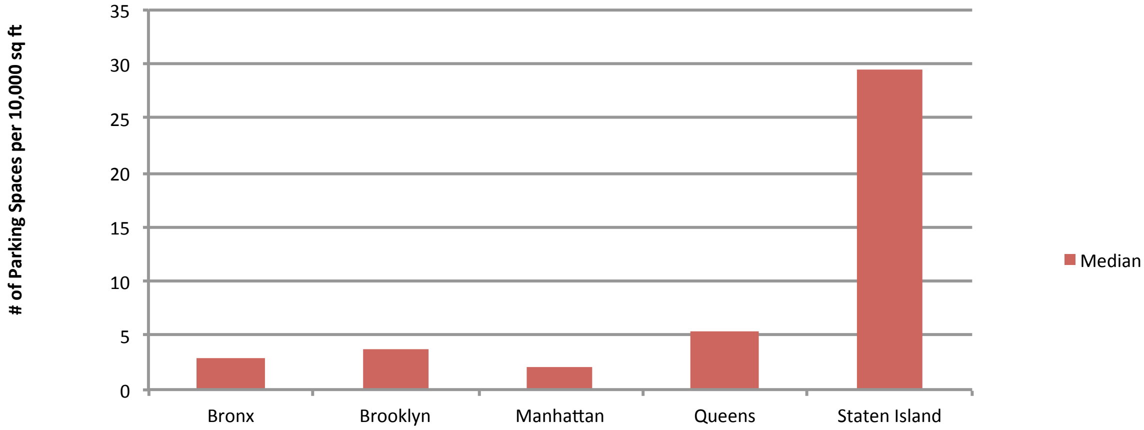
Appendix D-2 New Build Parking by Facility Type



Appendix D-3 Parking as a function of Building Size



Appendix E **Fast Charging Analysis**

Appendix E-1 Algebraic Determination of Taxi Fast Charging Needs

Seasonal Range Estimates

70	winter range (miles)
90	summer range (miles)
100	fall range (miles)

Fast Charge - Time to Charge and Charge Characteristics

80%	amount of battery capacity after a fast charge (if battery initially below 50%)
100%	amount of battery capacity after a fast charge (if battery initially above 50%)
120	miles per shift
30	time per fast charge (minutes)
10	time to get to a fast charger (minutes)
40	total fast charging time (minutes)

Data Table Variables

20%	% at which driver seeks fast charge (variable a)
70	range for data table (miles)
70	range (after fast charge, if starting charging above 50%)
56	range (after fast charge)

# of fast charges needed

a = % at which driver fast charges

x=# of fast charges

if a<50%

*120-70(1-a) = x(56-a*70)*

x= 120-70(1-a)/56-70a

if a>50%

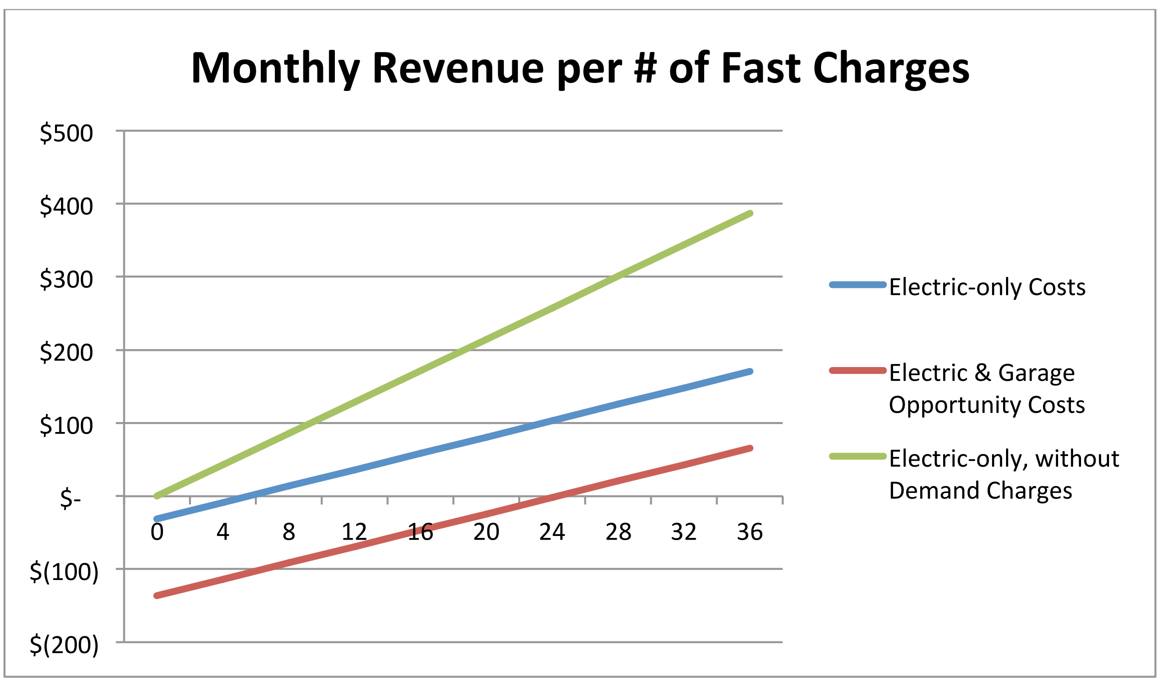
*120-70(1-a) = x(70-a*70)*

x=120-70(1-a)/70-70a

Appendix E-2 Fast Charging Cost Estimates

Simplified Demand Charges per Fast Charger

	NYPA	ConEd	
Demand Charges (KW)	-	Summer	Non-Summer
5	$157.10	$108.10	$86.10
10	$314.20	$216.20	$172.20
15	$471.30	$324.30	$258.30
20	$628.40	$432.40	$344.40
25	$785.50	$540.50	$430.50
30	$942.60	$648.60	$516.60
35	$1,099.70	$756.70	$602.70
40	$1,256.80	$864.80	$688.80
45	$1,413.90	$972.90	$774.90
50	$1,571.00	$1,081.00	$861.00



Appendix E-3 ConEd Building Fast Charge Analysis

The company did this analysis of buildings with attached commercial garages to determine the additional cost of an unmitigated fast charger. It assumes that a fast charger will add 50 kW to a building's demand. However, the buildings' current demand suggests that there is room to accommodate a fast charger without increasing over load through the use of load shedding or reducing a chargers demand during peak periods.

Original Bill					
# of Days	Date	CONS	Demand	Bill	Load Factor
29	2/17/2012	1301600	3530	$ 114,822.73	52
	1/19/2012				

30	9/16/2011	747200	1524	$ 73,652.60	68
	8/17/2011				

Original + 3000 kWhrs & 50kW demand					
# of Days	Date	CONS	Demand	Bill	Load Factor
29	2/17/2012	1304600	3580	$ 115,783.84	52
	1/19/2012				

30	9/16/2011	750200	1574	$ 75,380.82	66
	8/17/2011				

Appendix E-4 NYC Properties that lend themselves to fast charging

Properties Identified by the NYC Department of Citywide Administrative Services as having potentially large loads and convenient to inner core thoroughfares Likewise, these are specific properties that have the space and electrical capacity that lend themselves to EV fast charging.

DSNY – 44/44A Garage (1-1103-44 and 1-1104-1)

DSNY –Manhattan 1 Garage (1-595-87)

NYPD – Pier 76 Tow Pound (1-665-10)

Appendix E-5 Walkability.com Amenity Data for ConEd Gowanus Substation

The original intent was to use walkability scores to further refine potential fast charge locations. It turns out the walkability scores weren't fine-grained enough to reflect the amenities a fast charge user might care about. However fast chargers should still be placed with attention to amenities such as coffee shops and stores.

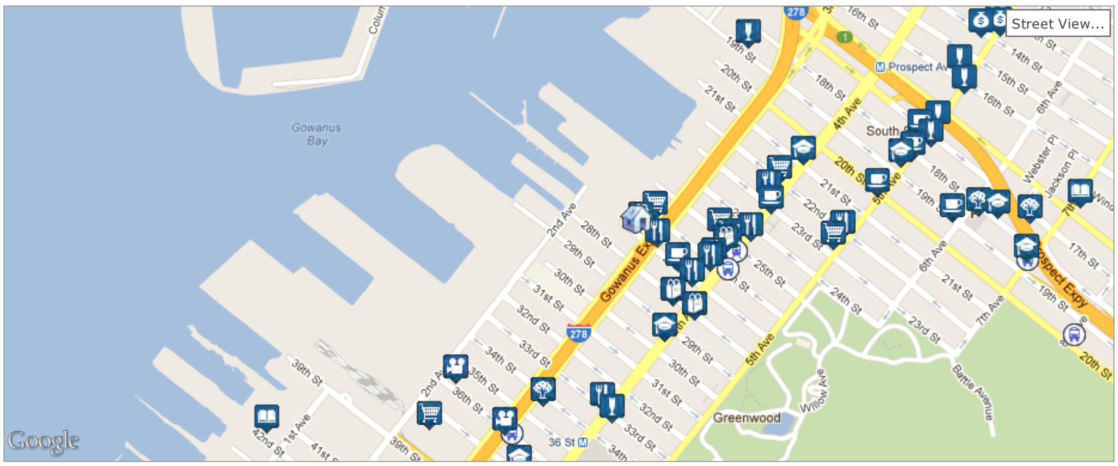
Walk Score
80
Out of 100

Very Walkable
99 27th St Brooklyn NY 11232

Share

Greenwood

Restaurants	
Quik Stop Restauran	0.01mi
Coffee	
Dunkin' Donuts	0.06mi
Groceries	
Alekwan Court	0.05mi
Shopping	
Leaders Inc	0.04mi
Schools	
PS 172 Beacon Schoo	0.18mi
Parks	
John D'Emic Senior	0.37mi
Books	
Brooklyn Comics & M	0.81mi
Bars	
Brooklyn Tiki Bar	0.34mi
Entertainment	
Brooklyn Museum of	0.46mi



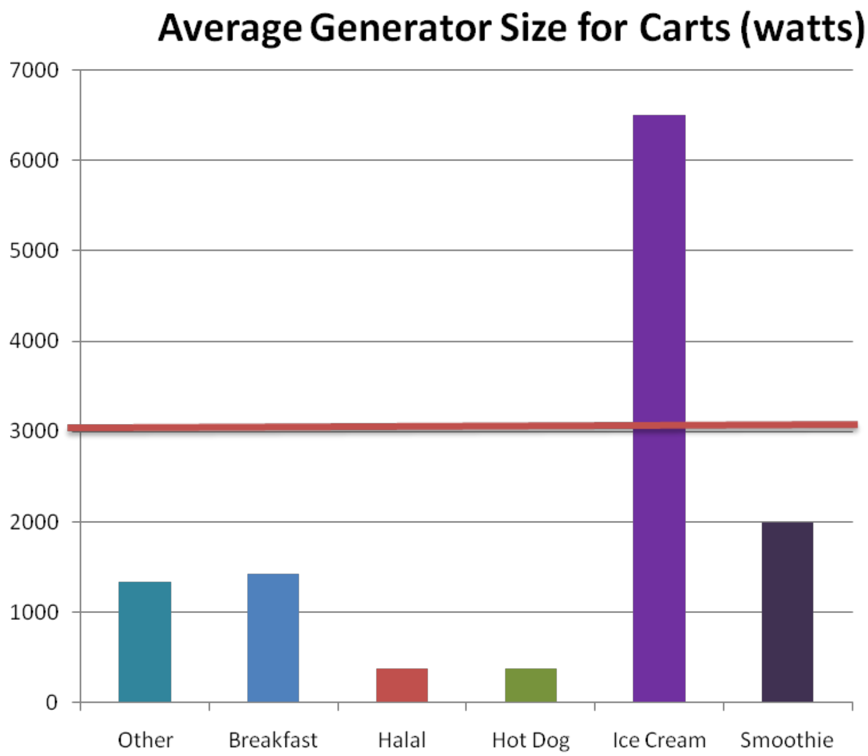
Appendix F Curbside Charging Resources

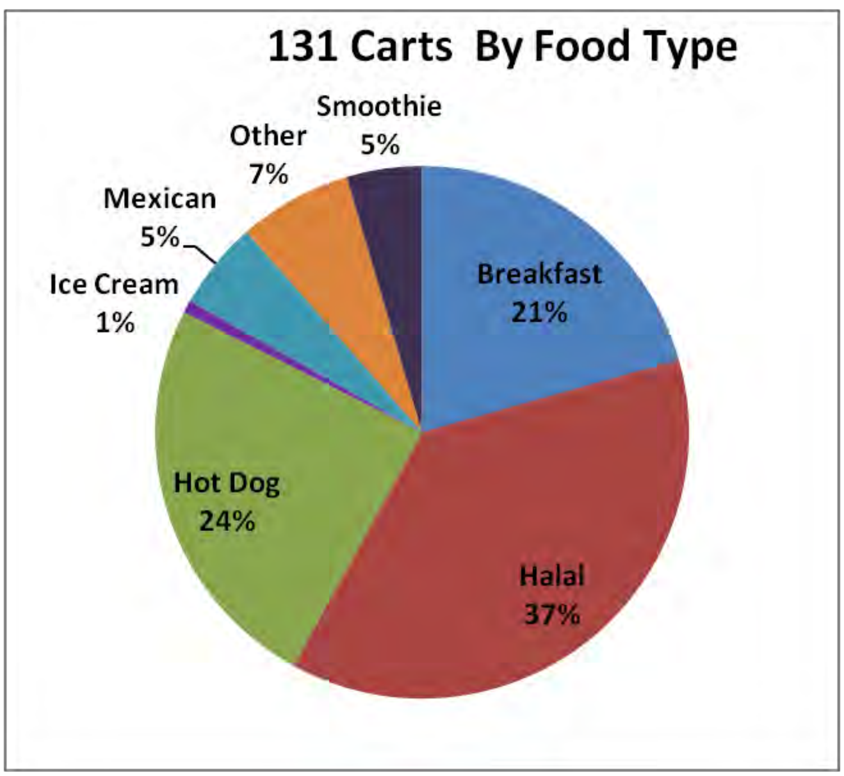
Appendix F-1 Technology Options Found by City for Curbside Electrification

Below are specifications of various curbside charger units found by the City for vendor electrification

	Vendor A	Vendor B (Eaton)	Vendor C
Authentication method	Credit card swipe / RFID	RFID (pre-filled)	Cell personal PIN number
Automatic shut off	-	No	No, ability to add later
Circuit breaker included in unit	Yes	Yes	Yes
Safety features	GFCI	GFCI	GFCI, internal fuse
Communication type	Cellular or wifi	RFID key, drive by meter reading	cellular
Internal metering accuracy	-	Utility grade	Utility grade class 2 minimum compliant
User interface	-	RFID key swipe to turn on and off	Cell phone/ web portal
Features	-	Locking provision to prevent cordset theft Support hook to prevent unintentional unplug with heavier EV cordsets	-
Dimensions	-	10"x10"x26"	Approximately 6.5"x6.5"x3" (final installation requirements will determine specific enclosure used)
Plug location	Front	Sides	External, places at install
build material	Stainless steel	Plastic	Fiberglass NEMA4x
UL Listed	No	UL® Listed to UL for EV use	Unit: no, protection components: Yes
NEMA certification	-	-	NEMA4x enclosure, plugs dependent on install

Appendix F-2 Detailed Results from Food Truck & Cart Canvas





Appendix G Car Share Analytics

Appendix G-1 Information from Original Zipcar Data

Variables Included for each reservation. Bold rows denote variables that are used in simulation

VARIABLE	TYPE OF VARIABLE
ID	Number
Reservation ID	**Number**
Anonymized Name	Number
Start Date	**Date & Time**
Start Time	**Date & Time**
End Date	**Date & Time**
End Time	**Date & Time**
Cancel Date	Date & Time
Swiped In Date	Date & Time
Swiped In Time	Date & Time
Swiped Out Date	Date & Time
Swiped Out Time	Date & Time
Minutes Late	Number
Total Distance	**Number**
Total Hours	Number
Used Hours	Number
On Hours	Number
Off Hours	Number
Total Charge	Number
Location	Name
Vehicle	Name
Vehicle Make	Name
Vehicle Model	Name
Zone	**Name**
GPS Enabled	Binary

Vehicles in Car Share Program with Their Miles per Gallon

Manufacturer	Model	MPG (combined)	MPG (city)
Ford	Escape	23	21
Honda	Insight Hybrid	41	40
Honda	Civic Hybrid	42	40
Honda	Civic	29	25
Honda	CR-V	24	21
Mazda	3	25	22
Mazda	3 Hatchback	25	22

Nissan	Altima Hybrid	34	35
Nissan	Sentra	26	24
Scion	xB	24	22
Scion	xD	29	27
Toyota	Prius	50	51
Toyota	Matrix	22	20
Toyota	Sienna	19	17
*Excludes vehicles used less than two times			
Average mpg	29.50		
All Mpgs are 2010 models from http://www.fueleconomy.gov/			

Appendix G-2 Example of Matching Algorithm Process & Results

Active Formulas - Reservations			
Index	Reservatio	Charge Nee	# of periods
1	364119209	4.288	11
2	363801092	10.208	10
3		0	0
4		0	0
5		0	0
6		0	0
7		0	0
8		0	0
9		0	0
10		0	0
11		0	0
12		0	0
13		0	0
14		0	0
15		0	0
16		0	0
17		0	0
18		0	0

2 bookings & their requirements

Active Formulas - Vehicles		
Vehicle ID	Booked? (0=n)	Charge Available
1	1	booked
2	0	18.71199991
3	0	23
4	0	23
5	0	23
6	0	23
7	1	booked
8	0	23
9	0	23
10	0	23
11	0	23
12	1	booked

Available vehicles & their state of charge

Algorithm matches trips to vehicles

Matching									
Vehicle/Trip	Reservation ID	Charge Needed	# of periods checked out		Vehicle Charge Available	Previously booked		Row	Car
1	364119209	4.288	11	1	booked	363801092		64	1
2	363801092	10.208	10	0	18.712	364119209		65	2
3		0	0	0	23	0		66	3
4		0	0	0	23	0		67	4
5		0	0	0	23	0		68	5
6		0	0	0	23	0		69	6
7		0	0	1	booked	364094566		70	7
8		0	0	0	23	0		71	8
9		0	0	0	23	0		72	9
10		0	0	0	23	0		73	10
11		0	0	0	23	0		74	11
12		0	0	1	booked	363758224		75	12

Vehicle/Trip	Reservation Trip: Gap Analysis (charge)												
	1	2	3	4	5	6	7	8	9	10	11	12	Eligible
1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
3	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
4	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
5	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
6	18.7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
7	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
8	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
9	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
10	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
11	18.7	13	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1
12	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1

Vehicle/Trip	Rank Analysis											
	1	2	3	4	5	6	7	8	9	10	11	12
1												
2												
3	2	5										
4	7	3										
5	3	1										
6	1											
7												
8	4	4										
9	8	2										
10	5	6										
11	6	7										
12												

Vehicle/Trip	Results				
	Car	Trip	End Trip S	Res Lengt	Res ID
1	-				
2	-				
3	-				
4	-				
5	5	2	12.8	10	363801092
6	6	1	18.7	11	364119209
7	-				
8	-				
9	-				
10	-				
11	-				
12	-				

Appendix H Beam Charging Garage Training Manual

The following manual was created by Beam Charging to explain to parking facility managers and attendants how to best provide charging and serve electric vehicles.

US DOE Clean Cities Community Readiness and Planning for Plug-in Electric Vehicles and Charging Infrastructure".

DE-FOA-0000451.

"NYC Electric Vehicle Readiness Project: Unlocking Urban Demand"

EVSE Garage Charging Training Manual:

Created by:

Beam Charging

Disclaimers

Contents

Figures

Acronyms

EV Electric Vehicle – vehicles powered by battery energy storage system (Plug-in Hybrid and 100% battery powered) available on-board the vehicle.

EVSE Electric Vehicle Supply Equipment – equipment that provides for the transfer of energy between the electric utility power and the electric vehicle.

kW Kilowatts – a measurement of electric power. Used to denote the power an electrical circuit can deliver to a battery.

kWh Kilowatt Hours – a measurement of total electrical energy used over time. Used to denote the capacity of an EV battery.

NEC National Electric Code – part of the National Fire Code series established by the National Fire Protection Association (NFPA) as NFPA 70. The NEC codifies the requirements for safe electrical installations into a single, standardized source.

NEMA National Electrical Manufacturers Association – develops standards for electrical products.

PHEV Plug-in Hybrid Electric Vehicle – vehicles utilizing a battery and an internal combustion engine (ICE) powered by either gasoline or diesel fuel.

SAE Society of Automotive Engineers – standards development organization for the engineering of powered vehicles.

VAC Voltage Alternating Current.

VDC Voltage Direct Current

1. Basic Administration

   The objective of this section is to guide the trainer to record specific trainee and garage information that is essential to good record keeping and aid in future training objectives. The trainer will record:

   a. Trainee Information:

      - Date and time of training
      - Name of trainees
      - Names of managers
      - Names of employees not present, but employed on site
      - Attendant shift times

   b. Garage information:

      - Garage address and contact information
      - Garage hours of operation
      - Garage capacity
      - Garage type
        - Outdoor lot
        - Single or multi-level covered lot
        - Basement
      - Size of garage or lot
        - Large (Over 300 spaces): Often allows for EVSE installation on main level
        - Medium (150-300)
        - Small (1-150): Often restricts EV movement after charging
      - Shape of garage or lot
        a. Rectangle
        b. Square
        c. Irregular shape: Can restrict movement and make EVSE charging and moving EV after charging difficult
      - Location of the EVSE in the garage
        - Proximity to Entrance/Exit: Good for attendants and users or future users to view EVSE
        - Level
        - Proximity to Electrical Supply: Closer to the electrical panels or feeder allows for easier installation and future additions
      - Traffic flow
        - Entrance traffic flow
        - Exit Traffic flow
      - Lanes of traffic in garage
        a. Multiple: Allow for EVSE to be mounted in convenient locations near the areas of traffic
        b. Single: Can restrict movement and doesn't allow for easy access to EVSE near main traffic areas
      - Current parking plan of the garage

- Current Transients Parking spots: Many EV users are transients and space in the current garage locations for transients has benefits of facilitating relocation and movement of the EV during the day/night
- Special Monthly Clients (front of the garage privileges)? : Many garages provide special front of the garage privileges for monthly parkers who pay a premium. These spaces are often great locations for transient EV drivers and EVSE installation. It allows for viewing of the EVSE and ability to quickly swap out the EV after the charging session is completed

2. Understanding Level I and Level II EVSEs

The objective of this section is to provide the garage attendant a general understanding of EVSE technology and how it is deployed. The garage attendant should understand the different levels of EVSE and how the differ in the delivery of electricity to an EV. The attendant will learn the various ways an EV is connected to an EVSE and the associated plugs and adaptors required. They will be trained on how long different models of EVs take to reach full charge. It will be explained on how multiple manufacturers are building EVSEs and some of the differences between each.

Typical EVs have onboard chargers that delivery DC power to their motors. AC to DC current conversation normally occurs at the onboard charger. Level I or Level II AC charging stations deliver AC current to the EV on-board charger where it is converted to DC. In the case of DC or "fast chargers" the conversion occurs off-board and DC power is delivered directly to the EV battery. DC charge times are a great deal faster, but the cost of these DC chargers and deployment remains very high. An outline of the differences types between Level I, Level II, and Level III, AC versus DC charging, and the different types of typical EVSEs are listed below.

a. Level I, Level II, and Level III (DC) Charging Power:
   - Level I: Up to 20 kWh
   - Level II: Up to 80kWh
   - Level III: More than 80 kWh

b. Types of Chargers

   - Level I (AC)/Portable EVSE: This charger plugs into a standard 3-prong outlet. It is typically used for in home use or emergency use while on road trips. They require a dedicated branch circuit with NEMA 5-15R or 5-20R receptacle that delivers 120V AC at up to 16 Amps and approximately 1.92kW maximum. Connection to the EV is typically done with the use of a J1772 plug (Fig X). Charging times for are typically very long (6-24 hours)

   - Level II AC EVSE: This chargers requires a dedicated branch circuit hardwired to a permanently-mounted EVSE with that delivers 240VAC/Single Phase, 4-wire (2 Hot, GND, Neutral), 40Amp Breaker up to 80 Amps and approximately 19.2kW maximum. Charging times would typically range from 2-8 hours.

   - Level I, II, III DC EVSE: The standards for DC charging have yet to be finalized, but these EVSEs require between 208-600 VDC and provide an output of up to 200kWh.

A typical Level II DC charger requires 208-450 VDC and delivers up to 90 kWh of power to an EV. The typically charging time is about 4miles/min or 10-60 minutes.

- Multiple Head EVSE : Curently many multiple manufactures are offering Dual head Level I/Level II (AC) EVSEs. These EVSEs allow for two vehicles to be charged simultaneously. They are typically either a Level I and Level II combination EVSE or a dual Level II EVSE.

c. Standard EVSE Plugs

- SAE (Society of Automotive Engineers) J1772 plug: These plugs are the North American Standard for Level I and Level II charging.

Figure 2 J1772 Connector

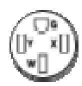
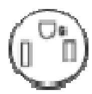
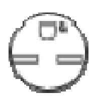
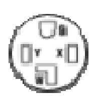
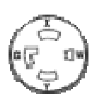
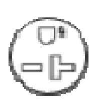
- ChAdeMO: These Level III plugs are in the process of being standardized, but the most common plug found currently in the US are based on the JEVS (Japan Electric Vehicle Standard)

Figure 3 ChAdeMO Connector

d. EVSE Plug adaptors: Almost of the US auto makers are current building EVs to receive the standard J1772 plug. However, Tesla (and some earlier EVs built before 2011) utilizes its own proprietary plug. In order for Tesla drivers to charge their EVs during road trips or at public charging stations, they must use adaptors. The two adaptor types they provide are the "Universal Mobile Adaptor" for emergency use, and the "J1772 Mobile Adaptor." For use with public EVSEs.

- Universal Mobile Adaptors (Emergency use)
  - Maximum Current: 40 Amp
  - Voltage: 120-240 VAC
  - Maximum Power: 9.6kWh
  - Cord Lengths: 18 feet

Figure 4   Tesla Universal Mobile Adaptor

Adaptor	Outlet	Breaker Rating (Amps)	Charge Time (Hours)
NEMA 14-50 (Included)	 RVs	50	6
NEMA 6-50	 electrical welders	50	6
NEMA 6-30	 AC units, commercial equipment	30	10
NEMA 14-30	 new dryers	30	10
NEMA L14-30	 generators	30	10
NEMA 10-30	 old dryers	30	10
NEMA 6-20	 motel AC units	20	14.5
NEMA 6-15	 AC units	15	19

NEMA 5-20	 standard 3-prong, higher current	20	37
NEMA 5-15	 standard 3 prong	15	48

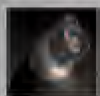
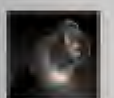
Figure 5 Tesla Adaptor Options

- J1772 Mobile Adaptor (Use at Public J1772 EVSE locations)
  - Maximum Current: 70 Amp
  - Voltage: 120-240 VAC Single Phase
  - Maximum Power: 16.8kWh
  - Cord Lengths: 4 feet

Figure 6 Tesla J1772 Mobile Adaptor

SAE International

SAE Charging Configurations and Ratings Terminology

AC level 1 (SAE J1772™) 	PEV includes on-board charger	*DC Level 1	EVSE includes an off-board charger
	120V, 1.4 kW @ 12 amp 120V, 1.9 kW @ 16 amp		200-450 V DC, up to 36 kW (80 A)
	Est. charge time:		Est. charge time (20 kW off-board charger):
	PHEV: 7hrs (SOC* - 0% to full)		PHEV: 22 min. (SOC* - 0% to 80%)
	BEV: 17hrs (SOC – 20% to full)		BEV: 1.2 hrs. (SOC – 20% to 100%)
AC level 2 (SAE J1772™) 	PEV includes on-board charger (see below for different types)	*DC Level 2	EVSE includes an off-board charger
	240 V, up to 19.2 kW (80 A)		200-450 V DC, up to 90 kW (200 A)
	Est. charge time for 3.3 kW on-board charger		Est. charge time (45 kW off-board charger):
	PEV: 3 hrs (SOC* - 0% to full)		PHEV: 10 min. (SOC* - 0% to 80%)
	BEV: 7 hrs (SOC – 20% to full)		BEV: 20 min. (SOC – 20% to 80%)
	Est. charge time for 7 kW on-board charger		
	PEV: 1.5 hrs (SOC* - 0% to full)	*DC Level 3 (TBD)	EVSE includes an off-board charger
	BEV: 3.5 hrs (SOC – 20% to full)		200-600V DC (proposed) up to 240 kW (400 A)
	Est. charge time for 20 kW on-board charger		Est. charge time (45 kW off-board charger):
	PEV: 22 min. (SOC* - 0% to full)		BEV (only): <10 min. (SOC* - 0% to 80%)
	BEV: 1.2 hrs (SOC – 20% to full)		
*AC Level 3 (TBD)	> 20 kW, single phase and 3 phase		

*Not finalized
Voltages are nominal configuration voltages, not coupler ratings
Rated Power is at nominal configuration operating voltage and coupler rated current
Ideal charge times assume 90% efficient chargers, 150W to 12V loads and no balancing of Traction Battery Pack

Notes:
1) BEV (25 kWh usable pack size) charging always starts at 20% SOC, faster than a 1C rate (total capacity charged in one hour) will also stop at 80% SOC instead of 100%
2) PHEV can start from 0% SOC since the hybrid mode is available.

Developed by the SAE Hybrid Committee ver. 031611

Figure 7 SAE Charging Configurations and Ratings

Make	Model	All Electric Range (Miles)	Battery Capacity (kWh)
Audi	E-tron	154	53
BMW	ActiveE	100	32
Fisker	Karma	50	20
Ford	Focus	100	23
GM	Volt	40	16
Mitsubishi	iMiEV	40	16
Nissan	Leaf	100	24
Tesla	Roadster	220	56
	Model S	160,230, 300	42, 65, 85

Figure 8 Estimated EV Charge Times (Level II 240 VAC)

e. EVSE Examples:

Figure 9 Level I Portable EVSE

Figure 10 Level II and Level II Dual EVSEs

Figure 11 Level III EVSEs

3. EV Garage Parking Methodology

When parking an EV in an indoor, outdoor, multi-level, or basement lot, the parking methodology needs to consider multiple factors.

a. EV Positioning: When deciding how to park the EV, an attendant must consider where on the EV is the J1772 receptacle. A typical Level II EVSE has a 15-25 foot cord attached to the plug. As described earlier, the Tesla comes with adaptors that will slightly increase that distance 4 feet with the use of a J1772 Mobile Adaptor.

Figure 12 Location of Charging Receptacle on an EV

- The EV should be parked to maximize the effective length of the EVSE cord and potentially allow for another (or more) EV to connect without moving the first EV. This is called “burying” the EV.

Figure 13 Burying the EV

The placement of the EV is determined not only of where the EVSE is located, or where on the EV does the plug attach, but also:

- What level of EVSE is available
- What is the make and model of the EV
- Type of garage patron
    - time of arrival
    - anticipated length of stay

b. EVSE Availability: Although Level II EVSE are most common in parking garages and lots, it may not be available and a Level I may be the only EVSE connection option for charger an EV. As outlined earlier a typical Level II charge can last between 2-8 hours, where a Level I charge can take between 6-24 hours to fully charge and EV. The placement of the EV must consider that the vehicle may need to remain in its location for at least 6 hours.

c. Make and Model of the EV: As listed earlier (**Figure 7**) different makes and models of EVs have varying battery capacity. The attendant must be aware of the EV and its battery capacity prior to deciding on where to place the EV to charge, or ask the driver what is the battery capacity of their EV and its current charge level

d. Type of garage patron: A garage or parking will typically have three types of patrons

- Transients (Commuters, tourists, other): Transients will normally arrive after 7am and leave at different times of the day and usually by 5pm. They will park in the garage between 1-4 hours. They should be parked in a flexible location in the vicinity of the EVSE when possible. You can expect these users charge for an average of 2.5 hours.

- Monthly parking patrons that occasionally leave and return to the garage: Occasional users are similar to transients, but may be monthly garage users, but only use their vehicles every once and awhile. These patrons may charge longer than a transient and may require night time charging due to their driving habits. These patrons can normally be parked in a more permanent location away from the EVSE after charging due to their infrequent usage. Their average charging session will be greater than 2.5 hours typically will need to be charged during night time hours.

- Monthly parking patrons that leave and return to the garage daily: Daily patrons will often leave sometime in the morning before 9 am and return by 5pm. These users will usually require night time charging and therefore need to be parked in the vicinity of the EVSE once they arrive when possible. Daily users may require more than 6 hours of charging to reach a full EV charge. These patrons typically will need to be charged during night time hours.

4. EVSE Operation

   a. EVSE Communication: Typical for public use EVSE communicate either over a private or public (with encryption) wireless or hard wired network. Many EVSEs can communicate amongst themselves via a local network and report back to a central server or station via a "gateway". This gateway is the means of the EVSE to communicate with the outside world and allow access to the EVSE for administrative, operational, or POS billing services. Coulomb Technology EVSEs and their Chargepoint Network provides a national wide network that utilizes existing cellular networks using either CDMA or GPRS technology.

   b. EVSE Plug and EV Communication: Typical EVSE and the standard J1772 provide a means of communicating with EV. This communication allows for the EVSE to acknowledge connection to the EV and vice versa. Upon coupling with the EV, the EVSE can then deliver the power to charge the battery and avoid a potentially dangerous situation where the plug is active and not plugged into the EV. Once connected to the EV, the EVSE can record valuable information for the consumer as well as the garage operators, EV service providers, and EVSE manufacturers:

      - EVSE Connected
      - Time and Duration of the charging session
      - Amount of power used
      - Green House Gas (GHG) savings
      - Type of connection (Level I, II, or III)
      - Address of the EVSE
      - Fees Charged (When applicable)

Station	Start Time ↓	End Time	Transaction Date	Duration (Hours)	Energy (kWh)	GHG Savings (kg)	Level	Address	Fees ($)

Figure 14 EVSE Usage Report Information

5. Billing: EVSE are typical provisioned as free or pay stations and with the use of a manufacture or service provider RFID card or key tag (**Figure 15 & 16**), or proximity credit card (**Figure 17**), a charging session can be initiated. These EVSE have a Point of Sale (POS) server built into the EVSE. If a patron does not have an RFID device or proximity credit card, they can call the manufacturer or service provider support number and have a session started with confirming identity or providing a credit card number.

Provider or Manufacturer	Support Number	Hours
Aerovirnment	1-888-833-2148	24/7
Beam Charging	1-888-758-4462	24/7
Clipper Creek	1-530-887-1674	8am-5pm PST
Coulomb Technologies	1-888-758-4389	24/7
Eaton	855-386-3873	TBD
Ecotality/Blink	1-888-998-2546	24/7
Leviton	1-877-338-7473	9am-6pm EST

Figure 15 EVSE Support Numbers

Figure 16 RFID Key Tag Example

Figure 17 RFID Card Example

Figure 18 Smart Chip "Proximity" Credit Card

6. Charging an EV (Demonstration): In a valet parking situation, there is a standard operating procedure for garage attendants to follow. The actual operation may differ slightly for different locations, but the basic order of events should be relatively the same.

   a. Standard EV Garage Charging Instructions (Valet garage)

      - EV enters the garage
      - Ask the EV driver would like to be charged and if they have their charge card
        - If no, have them call the customer support numbers provided
        - If yes, continue to the next step
      - Park the EV at the EVSE, turn it off
      - Present the customer's charge card, key fob, or smart credit card to the EVSE
      - Once approved, disconnect the J1772 plug from the EVSE and plug it into the EV
        - If the J1772 is not available, lift the door for the Level I socket
        - If a second J1772 is available, disconnect it from the EVSE and follow step "5"
      - Once charge complete or the customer wishes to depart, present the charge card to the EVSE and confirm ending a session
      - Disconnect the J1772 from the EV and place back into the EVSE holster

7. Safety in Charging: The J1172 standard plug is designed with multiple levels of shock prevention. The units are designed to work in an environment that contains dust, dirt, and even water. When not plugged in to the EV, no voltage is delivered to the EV. The EV initiates the flow of electricity upon coupling with the J1772 connector and ends the flow of electricity upon disconnection. If the connector is inadvertently pulled from the EV during a session, it is designed to have the pins that are energized to break away and a relay within the EVSE is designed to shut off power. In addition, the EV cannot be started when the J1772 plug is attached.

   It is important to understand that although EV charging and EVSE usage is safe, some basic safety procedures should be adhered to. A clean and clear environment free of water, debris, and dirt can prevent trips and falls, damage to the EVSE and plugs, and electrical shorts resulting in disruption in service. Cords and plugs should never be yanked, pulled, or dropped. Care should always be taken to properly holster the charging plugs and never leaving excess cord coiled on the ground or draped on another vehicle.

In the event of a problem or any unsafe situation, the EVSE electrical disconnect switch should be placed in the off position, the garage manager and the EVSE service provider should be notified immediately.

8. Trouble Shooting and Support: In the event that an EVSE is not working, some basic trouble shooting should be done to rule out simple power source issues or operator error. In the event there is an issue with the EVSE that needs the attention of the EVSE service provider, the attendants need to understand where to find the phone numbers for the service and support.

    a. Trouble Shooting: If an EVSE is not functioning and the proper charging procedures have been adhered to, the first item to check is the power source.

        - The power should be checked from the EVSE back to the electrical panel. This would require first checking the electrical disconnect switch next to the unit and then the garage circuit breaker. All breakers should be in the "On" position. If either are not, the garage manager and the EVSE service provider should be notified so a trained technician can service the EV and investigate why the disconnect or breaker was in the "Off" position.
        - The EVSE cord (s) and plugs should be checked for damage. If the equipment is damaged, then the unit electrical disconnect should be put into the off position and the garage manager and the EVSE service provider should be notified immediately for service.
        - The EVSE is designed and programmed to display notifications in the event of a problem. These messages should be recorded by the parking attendant. The following are examples of the notifications that an EVSE could display. Often the EVSE will display the action to be taken. This action is to be noted, but in all cases, the EVSE service provider should be notified so action can be taken to rectify any errors or and the action to be taken:

            - "Error" (Multiple types)

                i. Level I or Level II faults

                ii. Other

            - Unit not provisioned: The EVSE is not programmed

            - "Restricted use": The unit is restricting use to a customer

        - If the EVSE not responding to a card or key fob, first check if the card or key fob is a "Chargepoint" or "Beam" credential, or a proximity smart credit card. If the customer does not have one of these credentials, they can call customer service for support. If the customer does have one of these credentials, but the EVSE is not responding, any error message needs to be recorded and the EVSE service provider should be notified.

Note: During this section of training, some of the above scenarios should be demonstrated when feasible

b. Support: Often a garage attendant will need support while trying to charge an EV charging customer as due to unknown issue or error message displayed on the EVSE. Typically EVSE instructions, technical, or customer support numbers are posted on the EVSE directly or on signage posted by the EVSE service provider. If these numbers are not posted, the garage manager should be notified. This signage and instructions are the first level of technical support and can often solve any issues prior to calling your EVSE service provider. These signs may have the following information:

- Location of the EVSE in the garage or lot
- Step-by-step charging instructions
- Technical or customer support numbers

c. Additional information: It is important that garage attendants understand where customers can find additional information pertaining to EVSE charging or EVSE general services. This can be done by providing the customer access to material left behind or displayed by the EVSE service provider. Some examples of this information are:

- Pamphlets
- Business cards
- Garage Signage
- Website Information
- Phone Numbers

End of Section

Appendix

1. Example Field Training Sheet
2. ChargePoint Instructions (Coulomb, Siemens, Leviton, Only)

Field Training Sheet

Date/ Time Start/Time Finish	
Trainer Name/Phone #/email	
Garage Manager/Phone #/email	

Property Name		Property Type	Lot | Office | Res | Hotel
Site Address, City, Zip			
Company Name		Web Address	
Site Contact Name/Email/Phone			
Hours of Operation			
Describe traffic flow / pattern			
Total # of Parking Spots		# of Public / Private Parking Spots Available:	Public / Private
Garage Description			
Attendant 1/Shift		Attendant 4/Shift	
Attendant 2/Shift		Attendant 5/Shift	
Attendant 3/Shift		Attendant 6/Shift	
Training			Notes
	Garage Info collected	Y/N	
	Attendant info collected	Y/N	
	Level I and Level II EVSE Explained	Y/N	
	Connectors/Connections Explained	Y/N	
	EV Parking Strategy Reviewed	Y/N	
	EVSE Day and Night Usage Reviewed	Y/N	
	EVSE Communication/Billing Explained	Y/N	
	Means of Activation Reviewed	Y/N	
	EVSE Demonstration Completed	Y/N	
	EVSE Operation Safety Reviewed	Y/N	
	Demonstrated Power Shut off	Y/N	
	Reviewed Instructions	Y/N	
	Customer/Technical Support Reviewed	Y/N	
	Phone numbers and Signage Reviewed	Y/N	
	Training Aids/Pamphlets Left Behind	Y/N	

Additional Notes	

Appendix 2

ChargePoint Instructions (Coulomb, Siemens, Leviton, Only)

Welcome to the ChargePoint Network!

Look for the ChargePass logo

Tap your new ChargePass™ card against the scan symbol on any charging station displaying the ChargePass logo:

IMPORTANT! You must use the same ChargePass card to start and stop charging.

If you see a ChargePoint charging station without the scan symbol (for example, a home charging station), you won't need your ChargePass card—charging is as simple as plugging the station's connector into your vehicle.

Two Types of Charging

Level 1 Plug your own charging cord into the standard 120V outlet located behind the station's locking door.

Level 2 Plug the station's SAE J1772™ connector into your vehicle to charge at 240V.

Level 2 station — Dual-level station — Level 2 station

Stations with more than one charging option can charge two vehicles at the same time. These stations sequentially display the status of each charging port as #1 and #2.

Using your ChargePass card to charge your electric vehicle

Level 1 Charging

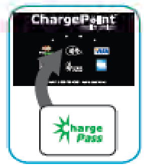
Use this method to charge at 120V by plugging your own charging cord into the charging station's outlet.

To start a charging session:

1. Plug your charging cord into your vehicle.
2. Tap your ChargePass card on the station's reader symbol.

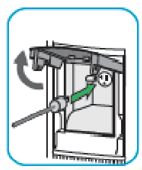
   When your card is authorized, the station displays a message indicating that the door is unlocked and you can insert the plug.

   IMPORTANT! Cords with clear or transparent plugs will not work.



3. Lift the door and plug your charging cord into the socket.
4. Push the door closed to lock in place.

   Charging begins when the door locks. The station displays a message indicating the the vehicle is charging.



To stop a charging session:

1. Tap your ChargePass card on the station's reader symbol.

   The station displays a message indicating that the door is unlocked and that you can remove the cord.

2. Remove the cord from the station's socket.
3. Push the door closed to lock in place.

   REMEMBER! Remove your cord from your vehicle and take it with you.

Level 2 Charging

Use this method to charge at 240V by plugging the station's connector into your electric vehicle.

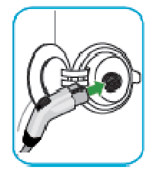
To start a charging session:

1. Tap your ChargePass card on the station's reader symbol.

   When your card is authorized, the station displays a message indicating that you can remove the connector from the holster and plug it into your vehicle.

2. Remove the charging station's connector from its holster and plug it into your vehicle.

   The station displays a message indicating that the vehicle is charging.



To stop a charging session:

1. Tap your ChargePass card on the station's reader symbol.

   The station displays a message indicating that charging has finished and to return the connector to its holster.

2. Return the station's connector to its holster.

   The station displays the duration and cost (if any) of your charging session.

chargepoint.net — 1-888-758-4389 — chargepoint.net

Appendix I Vehicle to Grid / Vehicle to Building Background

New York Electricity Market

In 2007, the Federal Energy Regulatory Commission (FERC) decided to reduce the barriers to entry for alternative power suppliers in the electricity market. The NYISO developed new market rules and software to allow a new class of resources called Limited Energy Storage Resources (LESR) to participate in the operator's electricity market. PEVs are expected to fall into this category of energy providers as do other technologies like Compressed Air Energy Storage (CAES) and flywheel systems.

LESRs are typically both consumers and generators of electricity. They are capable of storing energy when the load on the system is low and dispatching it back into the grid when the load is high. Unlike other ancillary service providers, LESR typically provide energy for very short duration typically in minutes. However, in New York the qualification for regulation services that offer capability are based on the maximum service that can be sustained for a minimum of one hour due to reliability rules in the state. This has been noted as a limiting factor by certain LESRs in New York.

These services will be compensated for their availability for a given period as well as the net power that they feed into the grid. The total value of market-based regulation services was $100 million in 2008.[63] LESRs are a subset of this overall market.

Mid Atlantic Grid-Interactive Car (MAGIC) Consortium

One of the early experiments in the V2G space has been the Mid Atlantic Grid-Interactive Car (MAGIC) Consortium. The partners in this consortium include University of Delaware, Pepco Holdings Inc. (Delmarva Power, Atlantic Electric, PEPCO, etc), ACUA, PJM Interconnection, AC Propulsion and Comverge. [64] The consortium also has Tesla motors, Google.org and the State of Delaware as "observers" to this experiment.

Gaps in standards for V2G

As part of its effort to enable large scale introduction of EVs and establish the EV industry, the American National Standards Institute (ANSI) released a Standardization Roadmap for Electric Vehicles through its Electric Vehicle Standards Panel. [65] The goals of the roadmap are:

1. "Facilitate the development of a comprehensive, robust, and streamlined standards and conformance landscape"

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[63] The prices for regulation services have dropped dramatically since 2010, further decreasing the potential of V2G.

[64] Vehicle to Grid Power (Briefing for: Federal Energy Regulatory Commission) by Willett Kempton http://ferc.gov/media/news-releases/2007/2007-3/10-22-07-v2g.pdf

[65] STANDARDIZATION ROADMAP FOR ELECTRIC VEHICLES - Prepared by EVSP of ANSI http://publicaa.ansi.org/sites/apdl/evsp/ANSI_EVSP_Roadmap_April_2012.pdf

2. "Maximize the coordination and harmonization of the standards and conformance environment domestically and with international partners."

The report assesses existing standards, codes and regulations and identifies existing gaps along with potential recommendations. It covers three large areas associated with EV standardization – Vehicle, Infrastructure and Support Services. Gaps that have been identified are prioritized depending on the time needed to close or address them.

Appendix I-1 Cost Benefit Analysis Model

Project Economics

	2012	2013	2014	2015	2016	2017
Net Purchase cost	(120,770,000.00)	-	-	-	-	-
Vehicle Purchase cost	(148,640,000.00)	-	-	-	-	-
Tax incentives	27,870,000.00	-	-	-	-	-
Government Funding	-	-	-	-	-	-
Operating expense						
Projected fuel savings	12,094,593.41	14,715,088.64	14,715,088.64	14,715,088.64	14,715,088.64	14,715,088.64
Maintenance cost savings	2,229,600.00	2,229,600.00	2,229,600.00	2,229,600.00	2,229,600.00	2,229,600.00
Battery Replacement						(89,184,000.00)
Training and contingencies	(19,323,200.00)	(19,323,200.00)	(19,323,200.00)	(19,323,200.00)	(19,323,200.00)	(19,323,200.00)
Electricity costs	(2,044,097.28)	(2,486,985.02)	(2,486,985.02)	(2,486,985.02)	(2,486,985.02)	(2,486,985.02)
Charging Stations						
Installation cost	(20,809,600.00)	-	-	-	-	-
V2G Revenue						
Frequency regulation	1,103,940.96	1,103,940.96	1,103,940.96	1,103,940.96	1,103,940.96	1,103,940.96
Net Income	(268,288,762.92)	(3,761,555.42)	(3,761,555.42)	(3,761,555.42)	(3,761,555.42)	(92,945,555.42)

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